Bay Area communities working together for a sustainable energy future.

BayREN Codes & Standards

Permit Resource Opportunity Program

PROP Final Report and Energy Code Resource Guide

April 1, 2015

Prepared by

Benningfield Group, Inc.
BKi
Association of Bay Area Governments

Confidentiality Note: The information collected for this report will inform BayREN efforts to provide Bay Area local governments with targeted tools and training to help comply with the California Building Energy Efficiency Standards. To ensure confidentiality, project-level information will remain anonymous. No project-specific information included within this report (such as building owner, occupant, project address, contractor, jurisdiction, or staff names) will be disclosed in any public reporting. Any questions or concerns about this confidentiality note can be addressed to BayREN by email at codes@bayren.org.

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1. Executive Summary

The Bay Area Regional Energy Network (BayREN) is a collaboration of the nine counties that make up the San Francisco Bay Area. BayREN implements effective energy saving programs on a regional level. The BayREN Codes and Standards program was designed to identify and share best practices and improve building code enforcement and building performance rates within the region. In 2013–2014, BayREN launched its Codes & Standards Permit Resource Opportunity Program (PROP), funded by public goods charges collected from energy utility customers. After conducting a survey of stakeholders, BayREN's energy code experts conducted a series of visits to fifteen Bay Area building departments to learn about energy code enforcement barriers and challenges, identify successful enforcement strategies, and gather data about the impact of discrepancies on building performance. This report examines the results of that effort.

Key findings of BayREN's 2014 PROP research include:

- Full conformance with all aspects of energy code documentation requirements is rare for all types of buildings and at all stages of construction.
- Many buildings were compliant with code minimums once code errors and omissions (discrepancies) were corrected. However, the presence of the errors, and the building energy savings represented by correction of those errors, are a lost opportunity for energy savings.
- Local governments, building departments, and their staff are very influential not only in enforcing minimum compliance rates but also in encouraging best practice building design and construction. Departmental pressures, such as limited staffing and competing health and safety priorities, constrain the ability of building departments to thoroughly review energy code requirements on every project.
- Building departments follow different processes and policies for permitting and inspection services. Although those differences should be accommodated, moving toward more consistent interpretations for projects that involve the energy code will help to improve enforcement across the region.

Based on these and other findings documented in this report, BayREN recommends:

- Developing new ways that energy information can be referenced in the field. For example, encouraging plans examiners to highlight key energy features to inspect in the field will help inspectors prioritize their limited time. Customized field inspection checklists can help plans examiners and counter staff prioritize the most critical energy features for the field inspector to review upon inspection.
- Adopting best practices, including: providing specialized energy code training, promoting consistent review and inspection procedures, using permit-specific handouts and checklists, and encouraging complete and well-documented project submittals.

- Incorporating energy code information into electronic permitting systems, and integrating building department permit databases with the state's Home Energy Rating System (HERS) registry.

In addition to PROP findings and recommendations, this report describes resources available to local governments seeking to improve energy code enforcement, including BayREN-developed guides and tools. Finally, this report provides considerations for future programs that could be developed regionally or statewide to target energy code compliance.

In 2015, BayREN will revisit building departments that participated in the 2014 PROP program. Each jurisdiction will receive training tailored around their specific needs. The goal of these visits is to encourage jurisdictions to reach beyond minimum code compliance and adopt a strategy that promotes better-than-code building practices.

A Note on Energy Compliance

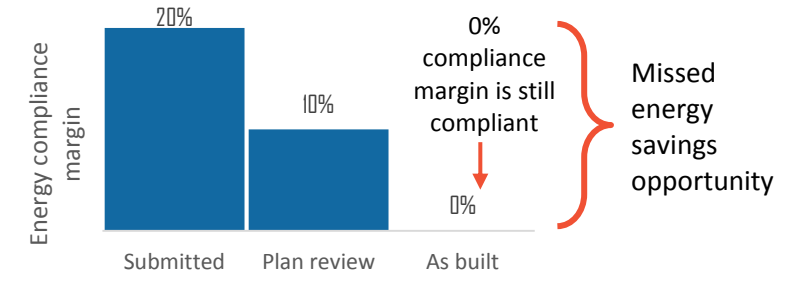
The terms *compliance* or *compliant building* can be characterized in a number of ways. The California Public Utility Commission's Energy Division Evaluation Team views energy compliance as a target minimum: a building constructed to meet its energy budget (based on modeling of the prescriptive package) is considered to be fully compliant. A building that performs better than this minimum is also considered compliant. Conversely, a building that does not achieve compliance can be close to or far away from the point of compliance.

Under this definition of compliance, projects can and typically do exceed compliance, sometimes by a substantial margin. Projects can contain compliance errors and product substitutions and still be deemed compliant. This is largely because few buildings are designed to perform at the exact target energy budget; there is typically a margin above the target that accommodates errors and substitutions during construction.

Instead of viewing compliance as an absolute point on a scale, another way to view it is as a relative point on a spectrum. In this view, buildings can be seen as *more compliant* or *less compliant* rather than simply compliant or noncompliant.

The energy impact associated with discrepancies has the potential to be substantial (and quantifiable). Compliance with the process, including submission of complete documentation, installation of required components, and proper testing of required functionality, may affect the building's energy performance. Figure 1 illustrates that errors and discrepancies found during the PROP visits may increase a project's designed energy usage, even though they do not technically create a noncompliant project.

Figure 1. Performance Impacts of Enforcement Problems in Compliant Buildings



To avoid confusion, this report will use the term *compliant* when referring to a building that meets minimum code requirements, regardless of whether errors are found. The terms *compliance margin* or *relative building performance* are used to describe the relative change in building energy performance at different stages of review. The term *discrepancy* characterizes errors with enforcement of California Building Energy Efficiency Standards that may or may not affect building performance or building compliance. The term *conformance* refers to adherence to required energy documentation and processes.

2. Introduction

The BayREN Codes & Standards Program involves a collaboration of the nine counties in the Bay Area to improve enforcement of Title 24 Part 6 of the California Code of Regulations, *California Building Energy Efficiency Standards* (known as Title 24 Part 6, or the Standards). In 2014, BayREN's Codes & Standards Permit Resource Opportunity Program (PROP) sent building code experts to Bay Area building departments to study energy code compliance and enforcement practices and to identify successful enforcement strategies. The results of those visits are collected here.

By sharing resources and best practices, cities and counties can use documented and well-established methods to drive better energy code enforcement while simultaneously reducing the burden on staff. Through the use of the materials, processes, and information contained in this document, local governments can make significant progress toward improving enforcement of the energy code, can act as advocates for improved building design and performance, and can serve as a model for building departments across the United States.

Purpose of this Report

This document works toward four primary goals:

1. Reporting the results of BayREN's 2014 PROP building department visits
2. Identifying best practices to help local jurisdictions enhance their enforcement of the energy code
3. Strategizing activities for the 2015 PROP follow-ups that build on 2014 findings
4. Sharing BayREN's unique tools and resources in a single document

The primary audience for this document is chief building officials (CBOs), who can use these findings, best practices, guides, and resources to help inform energy code enforcement at their local government building departments. This report is also intended for local government policy leaders and state regulatory agency staff who influence energy code programs, policies, and resources across the state.

BayREN Codes & Standards Permit Resource Opportunity Program

The San Francisco Bay Area includes nine counties—Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma—whose local governments comprise the Association of Bay Area Governments (ABAG). Each county has its own building department that typically serves the smaller towns and unincorporated areas, and each city usually has its own building department that governs building activity within its geographic limits. In all, there are 109 different building departments, or jurisdictions, serving a regional population of approximately seven million.

In 2012 the California Public Utilities Commission (CPUC) provided the Bay Area, via ABAG, an unprecedented opportunity to use ratepayer public goods funds collected by investor-owned utilities (IOUs) to develop strategies for improving building energy efficiency by working directly with local governments. In 2013–2014, BayREN planned and launched four programs: Financing, Multifamily, Single Family, and Codes & Standards. The goal of the Codes & Standards program was to identify ways to improve compliance and enforcement of the state's building energy code as well as to improve overall building performance. BayREN directly engaged building departments and other building industry stakeholders in the region to develop these findings and recommendations. BayREN has an active role in fostering greater regional policy coordination aimed at improved enforcement practices.

The Codes & Standards program consists of three primary tasks:

- *Regional forums*, events at which local government policymakers, sustainability staff, and building professionals meet to discuss policy and program design issues on energy efficiency and energy code compliance improvement
- *Permit Resource Opportunity Program*, in which BayREN's energy code experts conduct two-day visits at Bay Area building departments to evaluate and characterize energy code enforcement processes, learn first-hand about enforcement barriers and challenges, and identify successful energy code enforcement processes and strategies
- *Training*, in which building department staff and private sector professionals receive energy code training that focuses on enforcement processes and best practices

This report details the findings and recommendations derived from PROP visits to fifteen building departments in 2014. This report recommends follow-up activities for 2015 that build on 2014 findings. This report provides considerations for future regional or statewide programs to improve energy code compliance, developed in conversation with the participating PROP jurisdictions and the entire BayREN Codes & Standards committee. Lastly, this report includes BayREN-developed Permit Guides and Compliance Enhancement Tools.

3. The Power of Energy Codes

The standards codified in Title 24 Part 6 occupy a central role within California's statewide goal to reduce greenhouse gas emissions and improve economic conditions within the built environment. Cities and counties, as the agencies responsible for local adoption and implementation of these standards, are at the forefront of this effort to create the best building stock in the world. By ensuring that the design, construction, and renovation of California's buildings meet these ambitious targets, municipal governments can deliver long-term energy and cost savings that strengthen the economy while benefiting building owners and occupants for decades to come.

Key Benefits of Energy Codes

Energy codes are an essential component of transforming the construction market toward energy efficiency, water efficiency, distributed renewable energy production, development of a

smart and reliable power grid, and effective demand response activity. Updating the energy code every few years ensures that beneficial strategies can be implemented as soon as they are proven to be cost-effective and reliable. Incentive programs further increase building energy efficiency by enabling customers to install high-efficiency equipment, and regulators to evaluate emerging technologies and strategies. These emerging technologies and strategies are usually adopted as requirements in subsequent codes, in an iterative cycle that drives a process of continual improvement.

The biggest opportunity for energy savings is in existing buildings. Statewide, new housing construction has slowed in recent years: while an average of 170,000 new housing units were built annually between 2000 and 2007, this number has dropped to 60,000 a year between 2008 and 2014 as the state has responded to the national recession.[1] Most of California's 2050 building stock may have already been built.

The age of California's residential building stock also presents opportunities for energy savings: 58% was constructed before 1978, when the building energy code first became law.[2] Nationally, office buildings that were constructed before 1980 use about 10–15% more energy than buildings constructed after 1980.[3] In all, achieving greater energy code compliance among additions and alterations to existing buildings is essential to reducing the state's building energy use.

In addition to potential energy savings from properly enforcing the energy code in existing buildings, new construction is the only opportunity to "get it right the first time," especially for building features that are difficult and expensive to change afterward. By applying building science principles and advances in building technology, Title 24 Part 6 plays a key role in reducing operating and maintenance costs, and preserving long-term property values for owners, as well as providing affordable comfort for occupants. Figure 2 summarizes these benefits.

[1] California Department of Finance, January 30, 2015, www.dof.ca.gov/HTML/FS_DATA/LatestEconData/FS_Construction.htm.

[2] DNV KEMA, California Statewide Residential Appliance Saturation Study, 2009, adjusted to include new construction since 2009.

[3] Buildings Energy Data Book, 2012, http://tinyurl.com/kz7a9hl.

Figure 2. Key Community Benefits of Strong Building Energy Codes and Code Compliance

Saving energy	Building energy efficiency reduces the need for new power plants and grid improvements
Saving money	More-efficient buildings reduce utility bills for owners and occupants
Improving outdoor air	Reduced power plant emissions result in improved regional air quality
Improving indoor air	Energy-efficient heating, ventilation, and air conditioning (HVAC) systems and sealed building envelopes improve indoor air quality and foster human health
Improving comfort	Energy-efficient buildings are more comfortable, are easier to heat and cool, and satisfy occupant expectations more than standard buildings
Improving property values	Energy-efficient buildings retain higher property and sales values than standard buildings
Creating jobs	Standards contribute to employment in energy modeling, construction, engineering, manufacturing, industry, and support services
Improving safety	Energy-efficient buildings provide safety benefits during extreme outdoor temperature events and temporary power outages
Supporting technology	Code improvements encourage advancement in energy-efficient technologies
Energy independence	Reduced energy consumption supports national goals of energy independence
Reducing greenhouse gas emissions	Energy-efficient buildings use less electricity and natural gas than standard buildings, reducing greenhouse gas emissions and helping California achieve its climate goals

In light of the societal risks and costs associated with climate change, optimizing building design and equipment efficiency offers significant value beyond the building itself, as reflected by the insurance industry's growing interest in how extreme weather events affect their risk and rates.

Supporting Policy Goals

California has established numerous policy goals to address challenging environmental and social issues. These policy goals include preventing climate change, promoting environmental justice, improving energy efficiency, water conservation, and integrated energy planning (encompassing smart grids, renewable energy, and zero net energy buildings).[4] In 2006, passage of Assembly Bill 32, the *Global Warming Solutions Act*, required the state to reduce its greenhouse gas emissions to 1990 levels by 2020, using technologically feasible and cost-effective strategies. Because buildings account for about 40% of the nation's energy use and

[4] The California Energy Commission prepares an Integrated Energy Policy Report (IEPR) for the governor and legislature every two years.

greenhouse gas emissions, increasingly stringent building energy codes and standards are part of this process.[5]

In 2008, the CPUC adopted the state's first *Long Term Energy Efficiency Strategic Plan*, which was updated in 2011. Specific milestones are:

- All new residential buildings to be zero net energy by 2020
- All new nonresidential buildings to be zero net energy by 2030
- 50% of nonresidential existing buildings to be retrofit to zero net energy by 2030
- HVAC market to be transformed to optimize energy performance in California's climate
- All eligible utility customers to have the opportunity to benefit from low-income energy efficiency programs by 2020

Assembly Bill 758, the *Comprehensive Energy Efficiency Program for Existing Buildings*, was enacted in 2009. The purpose of this bill is to substantially improve the energy efficiency of California's existing building stock, a significant challenge.

Title 24 Part 6 is a critical component of delivering on each of these policy goals. Achieving these goals makes buildings more efficient, durable, comfortable, and affordable for the life of each building, and money saved on utility bills flows back into local economies. Builders also benefit from stringent energy codes, as associated increases in construction costs are offset by higher sales values and customer satisfaction. Also, regular code updates ensure that developers of innovative building products and processes have the opportunity and reliable market demand needed to invest in and deploy new efficiency strategies.

These ambitious and forward-looking energy codes and standards can yield their intended impact only if they are consistently and effectively implemented in buildings throughout the state. Local governments represent the front lines of building and energy code enforcement and interpretation at the local level, and therefore play a crucial role in ensuring that new construction and building retrofits incorporate energy-efficient features.

Barriers and Challenges

Despite the benefits of energy codes, there are substantial barriers to implementation and enforcement. Ensuring that buildings are built as intended under the energy code and surpass code minimums presents a challenge for local governments. Part 6 is just one part of Title 24, yet the regulations, compliance manuals, appendices, and supporting documentation together are thousands of pages of information, in addition to more than 250 iterations of compliance forms. The 2013 Standards also include a host of new requirements, new software systems for energy modeling, a new data registry, and a revised numbering system, all requiring substantial skill and frequent training to fully understand. With updates to the energy code occurring every three years, it is a daunting challenge to ensure that building department staff, in addition to

[5] Environmental & Energy Study Institute, *The Value and Impact of Building Codes*, 2013, www.EESI.org.

those designing and constructing buildings, understand and enforce the regulations consistently and comprehensively.

Title 24 Part 6 addresses the roles and responsibilities for enforcement of the building energy code. However, building departments that handle permitting and verification of the energy code have competing pressures for their time. BayREN found that energy code enforcement, while valued, may be deprioritized compared to other requirements of the building code—including structural, fire, electrical, plumbing, and mechanical requirements. Furthermore, Title 24 Part 6 is structured unlike other building codes, in that the performance approach and energy measure trade-offs provide more flexibility in how a building can achieve compliance. Flexibility, in turn, increases complexity and requires more forms to demonstrate compliance. This complexity challenges even the most conscientious code enforcement officials. Tools that support the importance and impact of their role, that help them prioritize their time, and that help them set clear expectations for their clients are welcomed by BayREN jurisdictions.

4. The Power of the Regional Approach

BayREN's Codes & Standards program is uniquely poised to address these challenges because it approaches energy code enforcement challenges by working directly with local government and building department staff. Key BayREN approaches include:

- Understanding how each jurisdiction categorizes, reviews, inspects, and documents building projects that trigger energy code requirements
- Identifying best practices and strategic opportunities for improving energy code documentation and building performance without disrupting or significantly changing each department's standard operating procedure
- Establishing program metrics and tools that can be used to evaluate regional energy code documentation, compliance, and performance improvement over time as a result of local government activities

The BayREN Codes & Standards program is composed of local government staff whose job it is to implement local, state, and federal law and policy. Leaders and members of BayREN's Codes & Standards Committee represent local governments in all nine counties. They have access to local officials as well as building department staff, who have direct access to all building projects permitted in their jurisdiction. On a daily basis, they are responsible for designing and implementing integrated policies that address and reconcile the various needs of their constituents. Collectively, the BayREN Codes & Standards team has the potential to impact energy code compliance, improve building performance, and advocate for best practice enforcement techniques in one of the most populous and innovative regions of the state and country.

By design, the BayREN Codes & Standards Program complements and supplements traditional statewide programs by leveraging community resources to effect change at the building department level. For example, BayREN is in a unique position to learn from its member jurisdictions about how the energy code is applied locally. This information allows the team to

customize its energy code enforcement trainings around real-world permitted projects provided by each jurisdiction. BayREN's access, influence, and expertise can reach several aspects of the code, including:

- Energy code enforcement activity
- Trigger points for energy code permits
- Project review and intake process
- Prioritization and staffing for energy code review on projects
- Staff knowledge of energy code (allocation of training time)
- Streamlining of energy code requirements and their application
- Data capture, reporting, filing, and records retention
- Training on energy codes and enforcement processes

5. Energy Code Compliance and Enforcement in the Bay Area

Application of the energy code requires substantial time and effort on the part of the private sector in terms of building design, construction practice, and documentation. Public sector enforcement activities also require substantial knowledge and time invested in both plans examination and building inspection.

Navigating the enforcement process requires an understanding of the basic structure of California's energy code. There are two approaches for demonstrating energy code compliance: the *prescriptive* approach and the *performance* approach (Figure 3). With both approaches, there are mandatory energy efficiency measures that must always be met.

Along with the mandatory measures, the prescriptive requirements form the basis for the energy code. A designer can follow the guidelines provided by the mandatory features and the prescriptive requirements in order to assure a minimally compliant building. As an alternative, if the permit applicant wants to change a prescriptive energy feature, he or she can use a performance approach to trade off features. Using the approved performance model, he or she must show that the building will use the same level of energy (proposed design) as that building would if it were built with the prescriptive features (standard design).

Because the performance method provides the most flexibility in design, it is typically favored for most new construction projects. It is also used for existing building projects where one or more prescriptive energy features prove difficult to incorporate into the design. For example, the performance method is frequently used for residential additions because the window area limits are too restrictive. By contrast, alterations (both residential and nonresidential) typically comply using the prescriptive method.

Figure 3. Comparison of Prescriptive and Performance Approaches to Energy Code Compliance

	Prescriptive approach	Performance approach
Mandatory measures	All mandatory measures must be met	All mandatory measures must be met
Prescriptive measures	All relevant prescriptive measures must be met	Prescriptive measures can be modified or traded, provided building meets energy budget

Regardless of the chosen approach, a *Certificate of Compliance* is required for most projects. It is prepared and signed by the individual(s) responsible for ensuring that the project complies with energy code. After the permit is issued and work has begun, contractors who install energy features must sign and submit a *Certificate of Installation* to the building department. For projects in which one or more energy measures require third-party verification, inspections and tests must be performed, and forms verifying features to be installed and working must be submitted. Building departments are responsible for collecting and verifying all energy documentation, including forms requiring registration.

The number of steps for enforcing the energy code by local building departments depends on the type and complexity of each permit application. The basic steps typically involve:

1. Fielding preliminary questions about permit applications and energy code compliance documentation
2. Application intake, fee collection, and entering each permit in the permit tracking software
3. Reviewing relatively simple prescriptive applications for alterations and issuing those permits at the counter—projects like roof, window, and HVAC replacements
4. For more complex projects, conducting a comprehensive review of plans and energy code documentation, including sending correction letters to those responsible for complying with the energy code and documenting design modifications required as a result
5. Inspecting the project in various phases of construction, collecting energy code forms from installing contractors and third-party inspectors as necessary, and issuing correction notices for installed energy features that do not match or that performed worse than those specified on the permit

Every local jurisdiction has its own scheme for categorizing building permit applications (e.g., commercial, single family, or multifamily buildings; new construction, additions, or alterations; required fees and inspections). No two permit classification schemes are alike, and very few consider energy code requirements. As a result, building activity that triggers energy code requirements is scattered across many permit categories, and accurately compiling all and *only* energy code-related activity is likely to be deemed time-intensive and costly, making analysis

difficult. In all, it has not been possible for building departments to efficiently and comprehensively analyze overall energy code compliance or the opportunity to improve relative energy compliance within their building stock.

PROP Visit Purpose and Background

During its 2013 launch, the BayREN Codes & Standards Program administered an online survey to stakeholders in the region. These included private sector building designers, energy consultants, and contractors, as well as public sector city planners, building officials, plans examiners, and field inspectors. The purpose of the survey was to introduce BayREN to the local building community, engage them to provide their perspectives on barriers and best practices for energy code compliance improvement and enforcement, and to identify and enlist local energy code leaders to participate in program development.

In response to the BayREN Codes & Standards Program's 2013 stakeholder survey and recruitment activities, fifteen city and county building departments volunteered to participate in PROP visits. The BayREN Codes & Standards team typically spent two days with an individual building department, engaging and interviewing key staff, observing their permitting processes, and conducting plan reviews and field inspections of several permitted projects that were complete enough for installed energy measures to be inspected and compared with permitted conditions. Following each visit, the jurisdictional director—typically the chief building official (CBO)—received a report summarizing any discrepancies found between permitted and installed energy features for the reviewed projects, and specific suggestions for improving energy code enforcement on commonly permitted projects.

The activities included in BayREN PROP visits are designed to yield the following information:

- Characterizing annual energy code-related building permit activity, by permit type and volume
- Identifying which permits involving energy code measures are plan-reviewed, and which are not
- Characterizing energy code compliance discrepancies during the application, plan check, and field inspection project phases
- Understanding logistical or organizational challenges and constraints inhibiting comprehensive energy code enforcement
- Identifying building department energy code experts and other best practice energy code enforcement strategies

This information helps BayREN prioritize its energy code improvement activities by jurisdiction and by enforcement role (counter staff, plan reviewers, building inspectors, and CBOs). In aggregate, these findings may in the future inform the development of a regional energy code compliance baseline, resources and recommendations for compliance enforcement improvement, and trainings that target unmet needs of the building departments.

6. Key Findings from PROP Activities

Note: *The PROP visits and findings contained in this report are not part of a formal study or evaluation and are not statistically significant, so findings cannot be projected across a region or a population of buildings. The findings are based on informal data-gathering and review aimed at identifying opportunities for improvement in the enforcement process and attempting to assign a relative priority or value to those improvements. PROP visits also provided the opportunity to gather some limited data about how buildings are built, common methods used to demonstrate compliance with the code, and other sample data that can potentially guide later work. The data have also been used to inform training content.*

Methods

In order to discover opportunities for improving energy code compliance enforcement at each jurisdiction, Benningfield Group, Inc. (BGI) staff conducted a review of up to five projects for each PROP visit. Each project was reviewed and discrepancies or errors were noted at the various stages in the enforcement process (submittal, plan check, and field inspection). The projects were scored on the basis of the frequency of discrepancies found; more discrepancies correlated to a lower compliance score ranking. In addition, an estimate of the relative impact the discrepancies had on overall energy performance was documented using an energy impact score. The purpose of the scores was to learn:

- To what extent the correct process for verifying and documenting energy code compliance had been followed
- To what extent correction of the discrepancies impacted building energy performance on a relative scale

The scoring approach BGI followed is described in Appendix A.

PROP Visit Building Characterization

BayREN reviewed a variety of project types in multiple locations during the PROP visits. In all, 15 building departments were visited and 49 projects were analyzed in depth. Figure 4 summarizes the building characteristics of the projects reviewed for this analysis. Each building department was asked to select projects for review based on their own self-selected criteria. Ideally the projects would be close to final inspection stage so that the team could see a complete package from submittal to construction. Project plans and energy calculations were provided. The team reviewed each project's energy code submittals, the design, and the constructed building to identify and communicate discrepancies between what was provided and what should have been provided based on the application of code to that particular building scope.

Figure 4. BayREN PROP Analysis Project Characteristics

Characteristic	Frequency
Building type	
Residential	30
Nonresidential	19
Title 24 climate zone	
2	10
3	10
4	6
12	23
Project type	
Addition/alteration	20
Tenant improvement (TI)	7
New construction	22
Compliance method	
Prescriptive	21
Performance	28

Key Finding: Complete and Error-Free Documentation is Rare

Only 16% of reviewed projects correctly met all of the documentation requirements of the energy code at all stages of review (Figure 5). Documentation issues included failure to document energy components of equipment, failure to post required forms at job sites, and incomplete and inaccurate energy information in the documentation.

Figure 5. Error-Free Energy Code Documentation at All Stages of BayREN's Review

Type	Error-Free Projects[6]	Total projects	% Error-Free
Additions/alterations	2	27	7%
New construction	6	22	27%
Residential	4	30	13%
Nonresidential	4	19	21%
Total	8	49	16%

Among the concerns found in the documentation of energy code requirements, several findings

[6] "Error-free" means that no discrepancies were found at any of the three stages of review (submittal, plan review, or as-built conditions).

stood out. Correct documentation was seen more frequently in the submittal of information for plan check, while revisions and field inspection documents failed to meet the requirements (Figure 6). The most common errors in documentation were missing energy information on plan sets, conflicting energy information on required forms, and missing field forms.

Figure 6. Error-Free Energy code Documentation at Each Stage of BayREN's Review

Stage	% Error-Free
Original submission	71%
Plan check	49%
Field inspection	57%

Key Finding: Half of the Projects Reviewed Performed Worse than Energy Documentation Predicted

For projects where discrepancies were identified, the review team found that the discrepancies frequently had a negative effect on building performance. Relative to building performance, BayREN found that more than half of all projects reviewed (51%) contained errors suggesting that the designed and/or constructed building would perform worse than predicted in the initial energy compliance submittal package.[7] The estimation method involved a professional judgment as to whether the error worsened building performance overall, whether it was a process error without necessarily impacting building performance, or whether it might have improved building performance. In some cases, models were built or modified to quantify the effect of the error. For more detail on the method used, see Appendix A.

For projects inspected post-construction (during the field stage), BayREN found that about a third of new construction projects may perform worse than their predicted energy budget as shown on the plans and in the energy calculations, while two-thirds of additions and alterations may perform worse than predicted (Figure 7). This difference between additions/alterations and new construction may be due in part to additions/alterations permits being submitted by owner-builders, who are less experienced with energy code requirements than the energy professionals who contribute to new construction permits.

[7] The submittals did not necessarily contain enough information to reveal whether those adjustments would affect overall energy budget compliance.

Figure 7. Relative Building Performance Post-Construction by Project Type

Type	Post-construction projects performing worse than predicted by submitted documents	Total projects	% projects performing worse than predicted
Additions/alterations	18	27	67%
New construction	7	22	32%
Residential	17	30	57%
Nonresidential	8	19	42%
Total	25	49	51%

The most common field errors affecting energy performance were the installation of measures that were less efficient than those documented and the failure to meet mandatory minimum measures as required by the code for all projects. When mandatory measures are not met, projects become noncompliant, independent of what other features are in the building. Less common errors included incorrect orientation documented for buildings and field change-outs that were not reflected in energy documentation.

Key Finding: Even for Compliant Projects, Errors Indicate Room for Performance Improvement

For many types of buildings, errors were found that had a negative effect on building performance. However, many of these projects were submitted with a relatively large compliance margin, and the effect of the errors did not impact overall building compliance for the applicable code in effect when the permit application was submitted. In other words, while the error would worsen predicted building performance when compared to what was submitted in the calculations, the building would still achieve the minimum performance standard. By identifying errors like these and requiring builders to build to the energy model, jurisdictions can improve energy performance for the region's building stock, regardless of code minimum requirement.

Figure 8. Number of Projects Meeting Energy Budget, Despite Discrepancies from Original Submission

Projects meeting minimum compliance threshold, but with discrepancies from original submission at field inspection	27
Projects meeting minimum compliance threshold, but with discrepancies from original submission at both plan review and field inspection	17

Key Finding: Discrepancies Tend to Cluster around "Themes"

The team found that, although each project revealed unique discrepancies, the discrepancies found could be grouped into types. Figure 9 illustrates the most common types of discrepancies identified in the PROP analysis, with further exploration of these themes below.

Figure 9. Types of Discrepancies Found during PROP Visits

Type of discrepancy	Frequency
Incomplete or conflicting energy documentation on plans	37
Installed measures perform worse than what was specified at permit stage	12
Energy documentation missing in the field	10
Inaccurate energy documentation on plans	9

Incomplete or Conflicting Energy Information on Plans

The most frequent discrepancies reflect the core problem of inconsistently interpreted and applied energy code. Many designers do not budget adequate time and resources for documenting conformance to code requirements, so the design elements reflected in the plan set and those that appear in the compliance documentation do not always correspond. In some cases, the design was changed between permit submittal and final inspection to accommodate new technology, like LED lighting, and the energy calculations were not updated to show the benefit provided by the technology upgrade. Some examples of incomplete or conflicting information include:

- For residential projects, window areas listed on the compliance certificate differed from those shown on plans.
- For residential projects, mechanical equipment installed was lower efficiency than listed on compliance certificate.
- For nonresidential projects, number of lighting fixtures shown on plans differed from number specified on compliance certificate.
- For nonresidential projects, wattage of lighting fixtures shown on plans differed from that specified on compliance certificate.
- For nonresidential projects, lighting controls were shown in the energy calculations but not shown on the lighting schedule.

Installed Measures Worse than Permitted

Designs and specifications are frequently updated during construction, but the energy documentation is not always updated to reflect those changes. In addition, sometimes energy specifications are not followed or are "value-engineered" out of a project because they are perceived to be costly without being essential to the construction or operation of the building. It is difficult for building inspectors to notice some of these discrepancies in the field. Some examples found during PROP visits include:

- For multifamily and residential new-construction projects, high-efficiency furnaces were documented in forms and modeling, but lower-efficiency furnaces were installed.
- For nonresidential projects, additional lighting fixtures and/or higher wattages were installed than were permitted.
- For nonresidential projects, lighting control settings were not installed according to the requirements found in design documents.
- For residential projects, more fenestration was installed than was modeled.
- For residential projects, installed roofing material did not meet cool roof specifications.

Energy Documentation Missing in the Field

Even with the best intentions, sometimes the required process to enforce the energy code cannot be followed due to missing information. In some cases, such as window labels, the items are removed by field crews before the inspector sees them. In other cases, required paperwork is misplaced, is not on site, or for some other reason is not available. Examples BayREN found include:

- NFRC labels missing from windows during field inspection
- Installation certificates not available during field inspection
- HERS verification certificates not available during field inspection

Inaccurate Energy Documentation on Plans

While most energy analysts endeavor to ensure accurate documentation, occasionally it contains multiple modeling or plan interpretation errors. Examples from PROP visits include:

- Plans that indicated two different building orientations, both of which were incorrect
- Submission of forms based on a certain climate zone, when the building was actually in a different climate zone
- Mechanical forms that listed the same value for SEER and EER

7. Options for Local Governments

Building departments consistently indicate a need for more refined and focused tools to assist in the enforcement of the energy code. This need stems from the incredible depth and complexity of the code requirements, and the limited staff available to conduct the

enforcement. One of the goals of the BayREN Codes & Standards program is to provide building departments and permit applicants with guides, procedures, and other resources to streamline their processes and improve enforcement at each stage of review. Specifically, these resources can help:

- Improve the quality of permit applications by ensuring that applicants know the necessary energy code requirements
- Provide information on permit management systems with the potential to expedite both plan review and inspection, while simultaneously improving coordination between the two
- Provide recommendations to make plan review both faster and more productive
- Help Bay Area building departments share their best practices in energy code plan review and building inspection

These recommendations pivot around common process themes, but individual application of these practices will vary for each building department, since each department has its own processes that recognize construction volume, relationship to clients, level of internal expertise, internal staffing structure, and other factors.

Electronic Permit System Enhancements

Local governments use a variety of permitting systems, including paper-based applications and forms for simple over-the-counter permits; electronic permitting systems such as Accela, CRW, and EDEN; and online systems. Every building department that participated in the 2014 PROP visits uses a permit tracking software system to document and manage local permits, including building permits. Each system is customized by the vendor for the particular needs and requests of the local government. Several jurisdictions are in the process of changing or upgrading current permit tracking software.

PROP visits revealed that none of the jurisdictions currently enters any energy code information into their permit tracking system. When BayREN asked about the feasibility of using these systems to track basic energy code information, at least one department insisted that they do not want their staff to have to enter any more information in the tracking software than they already do. Instead, these electronic permitting systems are used to capture data relevant to fee collection and jurisdictional operations (such as parcel number, assessor data, fees collected). Though the systems were not fundamentally designed to track energy code compliance information, they could be modified to include it.

All permit applications and their associated construction plans, specifications, and energy documentation are on paper, and each department devotes a substantial amount of floor space to their storage. After permits are issued, the documents are kept for reference by inspectors. When the permit is closed, documents are eventually scanned and stored electronically in the local permit database.

The most innovative permit tracking system, which was recently implemented by a Silicon Valley city, represents a radical paradigm shift from paper-based to paperless permitting. Not only are construction drawings submitted electronically, but different sheets or layers can be viewed and reviewed simultaneously by several local agencies, such as fire, public works, planning, and building departments.

As the state relies more on its HERS data registry to compile energy code compliance data, there may be opportunities to integrate building department permit databases with the HERS registry. BayREN's Codes & Standards program is considering PROP visit follow-up activities to demonstrate the feasibility and advantages of such integration.

Permit Applications: Getting Energy Information in the Right Places

While energy information is required for all permits that trigger the energy code, jurisdictions have varying policies about the placement of that information on plan sets. The most common source of that inconsistency is that energy information may be placed on a separate page or attached only to the permit application, using documentation generated on output forms from energy models such as EnergyPro or California Building Energy Code Compliance (CBECC). While this allows for easier revision of such information, it also makes it less likely that inspectors and contractors in the field will see the information to ensure that it is reflected properly in the structure. Placing the energy information directly on the plans can yield higher awareness, but also requires a revision to the full plan set for minor changes in efficiency characteristics.

For projects requiring building department plan review, BayREN recommends that the design features present in the approved/permitted *Certificate of Compliance* be incorporated into the construction plans and drawing set on the appropriate sheets, so that it is readily available at the building site for reference by all contractors and inspectors.

Options for Improving Energy Code Compliance and Building Performance

Few jurisdictions have the capacity to comprehensively review and inspect all energy code requirements within the time available. This section summarizes best practices found during BayREN PROP visits that help building departments expedite plan review and prioritize field inspection of energy code measures. The review team identified especially effective or efficient processes employed by building departments and identified these as "best practices."

Use of Permit Application Handouts and Plan Review Checklists

The sheer volume of requirements, conditions, and exceptions in the energy code makes it difficult for applicants and building department staff to understand what requirements must apply, which forms are required, and what information must be provided in each form. BayREN handouts (Appendix C) are specifically designed to help Bay Area applicants prepare complete and accurate documentation for each building project. Other handouts are available through the IOUs' Energy Code Ace website (www.energycodeace.com) and the California Energy Commission's Title 24 Part 6 education website (www.energy.ca.gov/efficiency/educational_resources.html).

While applicant handouts can improve the quality of submittals, checklists can streamline plan review of applications by identifying specific code sections, required information, and key items for plan review and field inspection. The Energy Code Ace website listed above provides a variety of checklists for building department staff to use for projects that trigger the energy code.

A Narrower Band of Tolerance for Inadequate Energy Compliance Documentation

One of the most common problems found during BayREN PROP visits was that the submitted energy documentation was incomplete and/or inaccurate. For example, even when performance-approach documents were prepared by a certified energy consultant, information on the building plans and specifications, which were prepared by other professionals, might not match the information on the documentation. In fact, several energy consultants who responded to BayREN's stakeholder survey indicated that they would prefer that plans examiners require them to correct errors by updating the energy performance model more often, because it is a necessary and collaborative part of the energy code education process and feedback loop. For projects that trigger HERS verification, consulting the online HERS registry is an easy way to identify required energy code compliance forms, and to verify that they are submitted, accurate, and complete. Requiring an "as-built" model where changes occur during the construction process will help quantify the effect of change during the construction process.

Also found during PROP visits were building projects whose energy compliance was impossible to verify in the field because the scope of the building project changed dramatically after the original permit application was approved, and the energy compliance model was not updated when the project scope was altered. To prevent these scenarios, jurisdictions should take a stricter stand on correction notices to permit applicants as soon as they become aware that the scope of permitted work has significantly changed, and that the original, approved energy code documentation is therefore incomplete or does not correspond to the building plans. Such projects might take longer to complete—a consequence not likely to be accepted by policymakers hoping to make development faster and easier. Therefore, this option entails a policy shift that could cause backlash in the building community.

Key finding: Budget constraints reduce energy review effectiveness

Some building departments mentioned during their PROP visits that they are resource-constrained. Their responsibilities continue to grow while their staffing levels decrease or remain stagnant. As a result, they spent less time on the energy features during plan review and field inspection. They also send fewer people to training. For example, they do not feel they can afford the time to train or expect permit technicians to review energy code requirements for over-the-counter permits, nor can they hire more inspectors to devote to energy inspection issues.

Energy Code Fundamentals Training

Because the energy code is updated every three years, it is difficult for plans examiners and inspectors to maintain current knowledge of the requirements, forms, processes, and recommendations. The IOUs offer residential and nonresidential versions of their *Title 24 Part 6: Standards Essentials for Plans Examiners and Building Inspectors* class in the BayREN jurisdictions. Each version is one day long and covers code updates, code navigation, and key aspects of the energy code. These classes are the most comprehensive summary of basic requirements. They are held across the region at PG&E facilities, and can also be presented on-site at local governments.

BayREN has developed its own suite of free energy code trainings (Appendix B), which complement the training content offered by PG&E and the statewide Codes and Standards program. BayREN trainings are shorter, but can be combined into day-long classes, and are delivered at local government facilities upon request. The BayREN trainings are delivered at the requesting jurisdiction and include customized content relative to that particular agency's permit types and processes.

Internal Energy Code Expertise

A potential method of improving enforcement, yielding both process improvement and building performance improvement, is to have in-house expertise up-to-date on the latest code requirements and compliance verification methodologies. Willingness to improve energy knowledge was identified among staff in several jurisdictions in the Bay Area, and higher levels of energy code compliance were typically found in those communities. Some departments had this expertise in-house, while other jurisdictions required outside review for certain aspects of the energy code.

Overall, jurisdictions that prioritized the energy code—either in-house or via outside inspectors—tended to exhibit a greater understanding in the following areas:

- Knowledge of the relevant energy code mandatory minimum requirements
- An understanding of the prescriptive code requirements by building type and project type (new construction or additions/alterations) for the applicable climate zone

- A working familiarity of the approved performance-based compliance software for each project type
- Mastery of the relevant forms that staff are likely to encounter at plan review and inspection

Training resources and tools are available to enhance the energy code enforcement skills mentioned above. Interested individuals or departments are encouraged to contact BayREN or visit the BayREN website (www.bayren.org/codes/resources) for more details.

> ***Key finding: Energy code experts make a difference***
>
> Building departments that have a formal or informal energy code experts on staff are more effective at staying updated with the changes in energy code and applying them appropriately within the department. These staff leaders act as subject matter experts and are relied on to help navigate the impact that new codes have on building plan review, inspection, and overall permit processes. Departmental experts tend to champion greater attendance at staff-wide training sessions, which leads to greater overall participation in their local ICC chapters, and a more uniform application of the code in their jurisdiction. They also build good will within the building community because staff members are seen as a resource for answering questions from the public about the complex energy code.

Networking and Collaboration

Several building department staff members who participated in PROP visits are active in local and/or state chapters of their trade organizations, including California Building Officials (CALBO), International Code Council (ICC), and the California Building Inspection Group. These organizations provide opportunities to discuss energy code enforcement issues and act collectively if needed. Furthermore, some jurisdictions are small enough to have frequent communication with local builders, contractors, energy consultants, and HERS raters. These relationships facilitate sharing of information about energy code updates, details, compliance issues, and how to best resolve them.

Options for Plans Examiners

The role of plans examiners in energy code enforcement is critical and highly variable. Plans examiners use their own judgment and a variety of tools and techniques to prioritize and review the greatest amount of information in the available time they have. This section summarizes best practices for effective energy code plan review under these conditions.

Internal Consistency in Energy Code Plan Review

BayREN's PROP visits revealed that the process of reviewing plans for energy code compliance varies significantly, even among staff in the same department. Effective practices and techniques used by one professional are often unknown to others. Developing a standard

energy code plan review process within each department would involve identifying and sharing best practices, and continuing to optimize that process for each jurisdiction. Establishing clear and consistent guidelines for the steps and time involved in energy code plan review can help clarify expectations for the process and expected outcomes.

Prioritizing Energy Code Plan Review

Plans examiners often do not have enough time to conduct a comprehensive review of energy code features, and the energy code is often deprioritized compared to direct health and safety codes. BayREN's training for plans examiners provides specific guidance on how to prioritize energy code plan review based on the nature of the building project and the time available for review. For example, "If you only have five minutes, check these things; if you have 15 minutes, check these things; if you have 30 minutes, check these things; and if you have an hour, check these things." This level of strategic prioritization can inform development of energy code plan review guidelines for building departments as mentioned above.

Highlighting Key Measures for Field Verification

A best practice found in some jurisdictions involves strategic communication between plans examiners and field inspectors. Plans examiners highlight key elements for inspectors to verify in the field on the approved plan set. For performance-method projects, prescriptive energy code requirements do not necessarily apply, so it is important for plans examiners to use the output from the energy performance model to call inspectors' attention to the specified energy features that need to be verified. If substitutions are made during construction, the inspector would require the contractor to prove the "as-better" condition or resubmit the energy calculations to prove that the building is still in compliance.

Options for Building Inspectors

The role of building inspectors in energy code enforcement is also critical yet highly variable depending on local conditions and priorities. For example, inspection times vary widely by geography, number of projects in the daily queue, complexity of the projects, and availability of project owners and contractors. The last is a significant factor as the energy code expands to include more technically rigorous components such as energy management systems, electrical controls, load disaggregation wiring, and other elements. Establishing and maintaining ways for inspectors to adapt to these variable conditions and ensure high rates of compliance is a challenge for all local governments.

This section lists best practices for enforcing effective energy code inspection under these conditions. These practices were found in high-performing jurisdictions, recommended in additional guides, or identified by building department staff as most effective in improving code enforcement.

Prioritizing Energy Code Field Inspection

Building inspectors are responsible for enforcing all building code requirements, not just the energy code. Due to limited time in the field, inspectors should prioritize those features that most impact energy code compliance and building performance.

To determine which energy code features to inspect, BayREN recommends that one or more staff attend trainings that are designed to facilitate this prioritization. Ideally, inspection priority lists should be customized by permit type and construction scope of each individual project. For specific recommendations regarding systems and construction types, inspectors should consider attending one of the compliance improvement trainings offered by BayREN. Interested parties can see available trainings at the BayREN website (www.bayren.org/codes/trainings).

Internal Consistency in Inspection Processes

In the PROP evaluations, BayREN found that the review process for individual building inspection can vary significantly across a single department. Techniques used by one professional are often unknown to others. Establishing a single policy for inspection practices and priorities can be a tool for sharing these practices, as well as for documenting how effectively the process is working within the jurisdiction. By setting clear and consistent process and time allotments for inspections, department staff can maintain clarity on expectations and performance, while applicants gain more certainty on review times and comments.

Managing Changes during Construction

A common challenge facing building inspectors is when energy features that were specified in the compliance documentation and approved as part of the permit are changed during construction. Examples include installed water heater, furnace, or air conditioner sizes or efficiencies; and window U-factor or SHGC values that are worse than those permitted. Inspectors must make judgment calls regarding whether to require that the energy performance model be updated to reflect these changes. Therefore, each jurisdiction should develop and provide guidance for dealing with these situations.

Options for jurisdictions to consider when developing these guidelines include:

- Create a process that involves plans examiners and field inspectors collaborating to identify and inspect key energy features. Have plans examiners highlight, and building inspectors reference, the overall building energy code performance margin, which is on the CF1R that is included in the on-site permitted plan set. A low (0–5%) original compliance margin is more likely to result in noncompliance than a significantly higher compliance margin (above 10%) when discrepancies exist.
- When the project scope changes significantly after the permit is issued—such as when a permitted addition turns into new building construction—require re-permitting.
- Require resubmittal unless the contractor can document an “offset” on site that accounts for the additional energy demands of the changed feature or system.

When in doubt, inspectors should consult the authors of the energy code documentation and require them to demonstrate that the change does not result in noncompliance.

Key finding: Simple strategies add up to results

BayREN found that one of the reasons some departments performed well on energy code enforcement is that they did the "little" things right, including:

- Performing regular cross-training among roles (for example, about once a month, inspectors work with plans examiners, and plans examiners ride along for field inspections)
- Relying on HERS raters to explain the raters' required forms as the inspection is completed
- Bringing tablets to the field with access to Title 24 Part 6, compliance manuals, Energy Codes Ace, blueprints, and the HERS registry during inspection
- Training permit counter staff to guide applications into the correct compliance path (performance vs. prescriptive), and to know what compliance forms are needed

8. Future Considerations and Next Steps

In 2015, BayREN will perform follow-up visits to the jurisdictions that participated in the original PROP visits. While the focus of these follow-up visits is still to identify, recommend, and assist in implementing strategies to improve energy code enforcement in building departments, BayREN will place renewed focus on several key activities.

Moving Beyond Energy Code Minimum as the Goal

BayREN will encourage jurisdictions to no longer view minimum energy code compliance as the goal of each project. When it becomes understood in the building community that the energy code is a "floor" and not a "ceiling," and that incorporating all possible best practice components into all designs is the actual goal of the energy code, documenting and enforcing minimum code compliance becomes less burdensome. Projects that participate in "beyond the code" programs will place less of a burden on building department personnel because these projects ensure that code minimum is not only met but surpassed.

When plan reviewers look for opportunities to help projects perform better than energy code minimum requirements, their role moves beyond code enforcer to code enhancer. BayREN's 2015 follow-up visit strategy will include helping plans examiners identify opportunities for submitted plans to not only meet but perform better than code requires. For example, a jurisdiction could work with its builders to encourage incorporation of reach code elements into their design. All projects of a certain size could receive recognition for the design review meeting (now required in the energy code but largely ignored) on the city's or BayREN's website. Smaller projects could be offered a checklist of standard upgrades and credits; the applicant would be asked to review and include as many of the items as possible. The goal of

this strategy is to change the paradigm of development within communities, and establish that simply "passing" the code requirements is not exceptional.

Targeting Building Types, Strategies, and Interventions with the Most Potential to Save Energy throughout the Region

This strategy involves identifying and focusing on the code enforcement strategies that work best in a very specific context and applying that solution broadly within the region. For example, BayREN may target small office buildings and recommend that building departments request or require that when a building of that type is altered or permitted for new construction, controls and displays be installed so that building managers can monitor energy performance. Another example might involve ensuring that every HVAC system replacement includes a HERS test with a duct leakage below prescriptive levels, and that owners have an incentive to replace the thermostat at the time of installation. The goal of this strategy is to focus on a particular code opportunity in a particular sub market and achieve a measurable improvement in energy code enforcement in that sector or with that measure.

Illustrating the Effect of Change during Tailored Debrief and Training Sessions

The follow-up PROP visits will include a tailored training component that centers on findings of a particular project suggested by the building department as typically problematic. This is the most responsive and widely accepted approach to changing building department behavior or processes. Building departments themselves know best where their problems lie and they will be motivated to implement the changes needed to help them understand what they feel is important to their job. The goal of this strategy is to ensure that the help BayREN offers is most relevant and most likely to be embraced.

Including a Direct Install Component or Offer during the Counter Permit Process

Building department personnel have face-to-face interaction with builders and community members every day. They also have an authoritative presence and tone during those interactions. Using the trigger of obtaining a permit to support a direct install may be a practical way to effect change. It may be judicious to explore delivery of a product or service in conjunction with a permit. For example, applicants approaching the counter for a reroof permit could receive a coupon that could be redeemed for cool roofing products. In this way they may learn about products that go beyond code and that help them meet code and ensure that efficient products are included in the design. The goal is to take action at every possible trigger event or opportunity to improve energy-efficiency in buildings.

Continuing to Collect Quality Data on Compliance Methods and Building Practices

There is a wealth of information within building departments that can help make code more practical to implement. Building department submittals and detailed permit data help those evaluating the code or creating and implementing code improvement strategies understand problems first hand in a way that will lead to improvement and change. In fact, quality data collected routinely can inform code change proposals before they are adopted and help insure that changes under consideration are practical and worthwhile.

9. Resources for Local Governments

In addition to the tools and training available through BayREN, the Codes & Standards program promotes resources to help facilitate effective implementation of California's Title 24 Part 6 (Building Energy Efficiency Standards) and Part 11 (Green Building Standards).

Below is a list of resources relevant to energy and green building codes and standards compliance and enforcement in California and local jurisdictions.

- The BayREN Codes & Standards webpage (www.bayren.org/codes) provides a comprehensive set of resources for energy code tools, guides, trainings, policy forums, and more. The site is hosted by the Bay Area Regional Energy Network, a collaboration of the cities and counties in the San Francisco Bay Area to address municipal energy efficiency issues.

- Energy Code Ace (www.energycodeace.com) is a website developed and provided by the California Statewide Codes and Standards Program, which offers free energy code training, tools, forms, and resources for those who need to understand and meet the requirements of Title 24 Part 6, including Trigger Sheets and Fact Sheets on technologies and common home improvement projects.

- Build It Green (www.builditgreen.org) is a membership-supported Bay Area nonprofit organization that works with building and real estate professionals, local and state governments, and homeowners to increase awareness and adoption of green building practice.

- CalCERTS (www.calcerts.com) is an approved Home Energy Rating System (HERS) provider. HERS is a process of administering diagnostic analysis to determine and produce data that provide a method of evaluation for California State-approved home energy efficiency ratings.

- California Advanced Lighting Controls Training Program (CALCTP) (www.calctp.org) is a statewide initiative aimed at increasing the use of lighting controls in commercial buildings and industrial facilities through education.

- The California Association of Building Energy Consultants (CABEC) (www.cabec.org) is a non-profit organization dedicated to providing up-to-date, reliable information about the California Title 24 Energy Standards and related building energy efficiency topics.

- California Building Energy Code Compliance (CBECC-Com) (www.bees.archenergy.com) is an open source project that may be used by code agencies, rating authorities, or utility programs in the development of energy codes, standards, or efficiency programs. Architects, engineers, and energy consultants may also use these tools to demonstrate compliance with energy codes or beyond-code programs.

- California Building Officials (CALBO) (www.calbo.org) provides information on the building official's role, committees, seminars, pending state legislation, and the general construction business. CALBO offers trainings on energy code issues, support for improving the Code, and advocacy for best practices.

- California Building Standards Commission (www.bsc.ca.gov) is authorized by California law to administer the many processes related to the development, adoption, approval, publication, and implementation of California's building code.

- California Energy Commission (CEC) (www.energy.ca.gov/efficiency) is the state's primary energy policy and planning agency. CEC's website includes a variety of resources to support strong implementation of the code, including the California Building Energy Efficiency Standards Appendices and Compliance Manuals, an Energy Standards Hotline for questions, access to software systems used to comply with the energy code, and energy training videos.

- California Lighting Technology Center (CLTC) (www.cltc.ucdavis.edu) is a not-for-profit research, development and demonstration facility dedicated to accelerating the development and commercialization of next-generation, energy-efficient lighting and daylighting technologies. CLTC provides market research, resources, lighting guides, working papers, and white papers, and the center conducts technology demonstrations and publishes reports and case studies on these projects.

- Contractors State Licensing Board (www.cslb.ca.gov) is charged with oversight of all contractors in the State of California and conducts a number of programs to ensure that contractors pull appropriate permits for work.

10. Appendix A: BayREN PROP Visit Project Scoring and Modeling Guidelines

Overview

These guidelines were used to help characterize the frequency and types of errors found in the field in order to direct the feedback and training in such a way that they provide the most value. This scoring method is not driven by statistical methods; it involves self-selection and other subjective elements. Therefore, claims should not be made about the state of compliance in the region based on these data alone.

Benningfield Group, Inc. (BGI) conducted a review of up to five projects for each PROP visit. For each project, discrepancies were noted at the various stages in the design process (submittal, plan check, and field inspection). The discrepancies were used to create an overall process conformance score for each stage. In addition, the discrepancies were used to modify any performance building models available to create a relative performance impact score. The purpose of the conformance scores and performance impact score was to establish:

- To what extent the correct process for verifying and documenting energy code compliance had been followed
- To what extent correction of the discrepancies impacted building energy performance on a relative scale

Data were collected representing adherence to the process (process conformance review). Review of submitted permit applications revealed answers to such questions as: Were the proper forms submitted? Were the required signatures obtained? Were HERS registry protocols followed? Did the submitted compliance documentation match the information on the plans and the measures installed in the field?

Project Selection Criteria

The projects were *self-selected* by the jurisdictions and included:

- Residential new construction
- Residential alteration/addition
- Nonresidential new construction
- Nonresidential alteration/addition

Process Conformance Review and Scoring Steps

Each project was evaluated in each of the permit stages: submittal, plan check, and field. The key elements considered in each step include:

- Submittal: Completeness of the compliance documentation and energy-related information contained in the permit file. For example, missing forms required for the

scope of the project constitute a discrepancy during the submittal stage, thus lowering the score.

- Plan check: Information on building plans when compared to the submitted compliance documents. For example, construction documents showing a level of insulation different from that shown on the compliance documentation illustrates a discrepancy during the plan check stage, thus lowering the score.
- Field: Compliance level of the building at field inspection when compared to the permitted plans and forms. For example, window labels showing U-factor higher than the maximum shown on the construction documents and energy calculations illustrates a discrepancy during the field inspection stage, thus lowering the score.

All scores were assigned based on how closely projects demonstrated completeness of all code requirements. The scores were based on an evaluation of how close the project came to meeting the code requirements in each of the three categories. Because the scoring involves professional judgment, this methodology cannot meet a level of rigor required to extrapolate results across a building population. Only three scoring levels were utilized.[8]

- Score = 0: No evidence was found of intent to demonstrate code process requirements.
- Score = 50: Some evidence was found of an attempt to demonstrate code process requirements, but full compliance with requirements was not achieved.
    - When a score of 50 was assigned, BGI indicated whether those discrepancies would impact building energy performance, based on professional judgment. For example, if the discrepancy impacted the process only, such as incorrectly completed forms, but the required features were included in the building design, a note was made that the error in following the process did not directly impact the energy use of the building under review.
- Score = 100: All energy code requirements were met and fully documented, plans contained the required information, or required features were installed in the building.
- Not applicable or not available (N/A): If any of the above stages were not reviewed. For instance, an alteration project permitted at the counter will not have a plan check. Additionally a project that has already passed final inspection or a project that was not accessible for a field visit would not be field-inspected.

[8] The scoring methodology follows that used in the original compliance study by Cadmus (formally Quantec) and BGI. Khawaja, Sami, Ph.D., Allen Lee, Ph.D., and Michelle Levy, *Statewide Codes and Standards Market Adoption and Noncompliance Rates,* Rep. no. SCE0224.01, Quantec, 10 May 2007, www.calmac.org/publications/Codes_and_Standards_Final_Report.pdf.

Energy Performance Impact Score Approach

The energy performance impact score was originally intended only to capture "as-submitted" compliance margins of buildings from performance files so as to begin to build a dataset of buildings in the region; it was not to be used in any quantitative way.

However, because it is also useful to illustrate the effect of discrepancies found in the field, an attempt was made to estimate the impact of the discrepancy on the overall building performance. This effort relies on the judgment of the reviewer and is highly subjective. The performance scores for individual projects indicate the relative importance of errors found. Frequently, building department staff would ask, "Does this error impact compliance?" This is an important question to begin to address. Finding an error and demonstrating for building department staff the energy effect of discrepancies makes training more powerful.

BGI used the original building energy models whenever possible to determine a project's starting energy performance impact score. For example, a project with a submitted compliance margin of 10% is shown as 110. For each project, BGI attempted to acquire energy models (for example, EnergyPro .bld or Micropas .mpp) from permit applicants or energy consultants. When electronic models were not available, BGI used submitted compliance margin data from the paper copies of the performance output forms as a baseline, and notes were added to explain any impact on the energy performance score.

Each project was reviewed for completeness and accuracy. Discrepancies between submitted plans and compliance documentation were noted. BGI then modified the as-submitted model when available to reflect any discrepancies observed. Where electronic models were not available, the effect of the error was estimated and noted as an estimate in the database. This revised compliance margin represents the plan check-corrected condition of the project and serves to illustrate the energy impact of discrepancies.

BGI accompanied a building inspector to the selected buildings. The models representing the plan review condition were modified as needed with field inspection data to illustrate the energy performance impact of discrepancies found in the field versus those in the plan. For example, if the energy calculations specified a variable frequency drive on the HVAC fan motor but none was specified or installed in the field, the energy model was revised to reflect that change.

Prescriptive Method

If the design team used the prescriptive compliance method for the selected project, BGI reviewed each permit package and assigned a score based on a very simple rubric:

- Score = 120: Project or measure performs significantly better than energy budget (as-submitted or plan review) or the installed measures perform significantly better than the minimum requirements (field inspection).
- Score = 100: Project or measure achieved compliance with a close margin.

- Score = 80: Project or measure would not comply upon installation (as-submitted or plan review) or upon inspection installed measures did not meet the minimum requirements (field inspection).
- Other score: Where a more detailed estimate could be calculated, it was noted. For example, on a lighting-only alteration where 1000 watts of lighting were allowed and 600 watts were installed, the compliance margin was 140.
- Not applicable or not available (N/A): No data were available for the project phase.

All prescriptive energy performance impact scores are marked as estimates and should not be extensively analyzed as a dataset. Each score that deviates from 100 contains an explanation for the estimate in the notes field.

11. Appendix B: BayREN Training Descriptions

2013 Title 24 Part 6 Compliance Enhancement Strategies for Nonresidential Envelopes

Workshop 1: Fenestration Performance—Improving Compliance

Introduction

Building department plans examiners and field inspectors often need help prioritizing their review of envelope efficiency requirements for nonresidential buildings. The 2013 Energy Code introduces new requirements, forms, and processes, which complicate this issue. This training provides specific strategies to improve enforcement with NR envelope measures.

Series Goal: Provide building department staff, and the building professionals with whom staff interacts, with a focused, highly specific set of tools and strategies for enhancing energy code compliance in nonresidential building envelopes.

Topics Addressed by This Training

- Basics: Fenestration Types, Performance Values and Terminology
    - Vertical vs. Skylight
    - Fixed, Operable, Curtain Wall, and Glazed Doors
    - Frame Types
    - NFRC Performance Values
    - Dynamic Glazing (also called Chromatic Glazing, Smart Windows)
    - Relative SHGC
- The Compliance Process
- New Prescriptive Requirements for Windows (What's Required)
    - Area: Max Window-to-Wall Ratio, West and Total
    - Maximum Area-Weighted U-factor
    - Maximum Area-Weighted RSHG
    - Minimum Area-Weighted VT
- New Prescriptive Requirements for Skylights (What's Required)
    - Area: Skylight-to-Roof Ratio
    - U-Factor
    - SHGC
    - Skylight Impacts on Daylighting
- Non-NFRC Rated Products (Non-tested)
    - The New Fenestration Forms
    - NRCC-ENV-02-E
    - NRCC-ENV-05-E

    - NRCA-ENV-02-F
- Managing Product Substitutions in the Field

Workshop 2: Site-Built Fenestration—Concepts and Methods

Introduction

Building department plans examiners and field inspectors often need help prioritizing their review of envelope efficiency requirements for nonresidential buildings. The 2013 Energy Code introduces new requirements, forms, and processes, which complicate this issue. This training provides specific strategies to improve enforcement with NR envelope measures.

Series Goal: Provide building department staff, and the building professionals with whom staff interacts, with a focused, highly specific set of tools and strategies for enhancing energy code compliance in nonresidential building envelopes.

Topics Addressed by This Training

- Site-Built Fenestration vs. Field-Fabricated Fenestration
- Documenting and Verifying Site-Built Fenestration Compliance
    - Step 1: What is Required?
    - Step 2: What is Specified?
    - Step 3: What is Installed?
- Site-Built Fenestration: Roles and Responsibilities for Design, Fabrication and Installation
- The New Fenestration Forms
    - NRCC-ENV-02-E
    - NRCC-ENV-05-E
    - NRCA-ENV-02-F
- Determining Performance Values for Site-Built Fenestration
    - Default U-factor – Table 110.6-A
    - Default SHGC Table – Table 110.6-B
    - Default VT Values
    - Alternative Default Fenestration Procedure (Using Center-of-Glass U-factor)
    - NFRC Component Modeling Approach Software Tool (CMAST)
- Important Takeaways
    - Determining Performance Values of Installed/Specified Fenestration
    - Field Verification of Site-Built Fenestration – Priorities
    - Field Verification of Site-Built Fenestration – Techniques

Compliance Enhancement Strategies for Residential Buildings

Workshop 1: Envelope Assemblies—Improving Compliance

Introduction

Building department staff often need help prioritizing their plan review and inspection of energy code requirements for residential buildings. The 2013 Energy Code introduces new requirements, forms, and processes, which complicate this issue. This series will provide specific tools and strategies to improve enforcement for residential new construction.

The goal of this series is to provide building department staff, and the building professionals with whom staff interacts, with a focused, highly specific set of tools and strategies for enhancing energy code compliance of new single-family residential buildings.

The learning objectives of this workshop are to understand the purpose and application of envelope assemblies and performance values, determine where to find this information on the compliance documentation and the plans, and determine whether those features installed in a building meet or perform better than permitted values.

Topics Addressed by This Training

- Previewing Best Practices and Tips
- The Compliance Process
- Overview of Heat Flow through Building Assemblies
    - What is Heat – British Thermal Units
    - Conduction
    - Convection
    - Radiation
    - All Three Forms of Heat Transfer Happen in a House
    - Aligning Insulation with Air Barrier
- How Heat Transfer Translates to Building Assembly Performance Value
    - R-value and U-factor
    - Solar Reflectance and Thermal Emittance for Cool Roofs
- Overview of Building Assemblies
    - Insulation Types—Framed Assemblies
    - Insulation Types—Non-Framed Assemblies
    - Types of Air Barriers
- Factors Impacting Performance Values in Building Assemblies
    - The Impact of Framing on Assembly U-value
    - Introduction to Joint Appendices JA4
- Overview of Mandatory and Prescriptive Envelope Requirements
    - Joints and Other Openings – Mandatory Measures

    - Roof/Ceiling - Mandatory Measures
    - Walls - Mandatory Measures
    - Prescriptive Measures (review table 150.1-A)
- HERS Verification of Residential Envelope Measures
    - Quality Installation of Insulation (QII)
    - Reduced Infiltration (Blower Door Test)

Workshop 2: Fenestration Performance—Improving Compliance

Introduction

Building department staff often need help prioritizing their plan review and inspection of energy code requirements for residential buildings. The 2013 Energy Code introduces new requirements, forms, and processes, which complicate this issue. This series will provide specific tools and strategies to improve enforcement for residential new construction.

The goal of this series is to provide building department staff, and the building professionals with whom staff interacts, with a focused, highly specific set of tools and strategies for enhancing energy code compliance of new single-family residential buildings.

The learning objectives of this workshop are to understand the purpose and application of fenestration performance values, understand the purpose and application of permanent fenestration shading devices, determine where to find this information on the compliance documentation and the plans, and determine whether these features as installed in a building meet or perform better than permitted values.

Topics Addressed by This Training

- Overview of Solar Energy and Heat Transfer in Fenestration
    - Cooling Loads and Orientation
    - Solar Gains
- How Solar Energy and Heat Transfer Translate to Fenestration Performance Values
    - NFRC Labels
    - U-factor
    - SHGC and VT
    - Glazing Technologies
    - Overhangs, Side Fins and Other Shading Devices

Residential Forms and Submittal Best Practices (Additions)

Workshop 1: Preparing 2013 Energy Code Submittal Packages for Residential Additions

Introduction

Designers, contractors and energy consultants who prepare residential building permit applications often need help determining what energy code compliance documentation to include. Residential additions pose specific challenges related to working with existing versus proposed features. The new 2013 code introduces new forms and processes, which complicate this problem.

The goal of this series is to provide private sector building professionals involved in the preparation or submittal of energy plans, and the building department staff with whom those building professionals interact, with a comprehensive overview of the expectations, best practices, and challenges for submitting energy code compliance documents.

The goal of this workshop is to introduce the overall process behind the 2013 energy code compliance documents and discuss how the various compliance approaches are accommodated by the compliance documents.

Topics Addressed by this Training

- Understanding the Forms 1-2-3
    - Step 1 – Document What is Required With the CF1R
    - Step 2 – Document What is Installed With the CF2R
    - Step 3 – Document What is Verified with the CF3R
    - 2008 Forms vs. 2013 Forms
- Forms That Will Commonly Be Used for Additions
    - CF2R Certificates of Installation (Prescriptive Approach)
    - CF3R Certificates of Verification (Prescriptive and Performance Approach)
- HERS Registry
    - Track the Status of Projects from Start to Finish
    - Keeping Track of Revisions
    - Accessing the HERS Registry
    - Your Online Energy Code Advisor: It's Automatic
- Prescriptive Compliance for Additions – What's New?
- Prescriptive Requirements by Size Category
    - Additions ≤ 400 ft2
    - Additions > 400 ft2 and ≤ 700 ft2
    - Additions > 700 ft2
- Where to Place Energy Feature Information on the Plans
    - Prescriptive Sets the Target for Performance

- Energy Use Summary from CF1R-PRF-01-E
- Performance Approach for Additions
- Compliance Approach Options (Additions Only, Additions + Alterations, Existing + Additions + Alterations)
- E+A+A Example

Workshop 2: Aligning Energy Code Documentation with Installed Features for Residential Additions

Introduction

General contractors, specialty contractors and installers are now required to document proper installation of required energy features. They often need help determining what energy code compliance documentation to fill out at signature. Residential additions pose specific challenges related to working with existing versus proposed features. The new 2013 code introduces new forms and processes, which complicate this problem.

The goal of this series is to provide private sector building professionals involved in the documentation process, and the building department staff with whom those building professionals interact, with a comprehensive overview of the expectations, best practices, and challenges for completing and tracking energy code compliance documents.

The goals of this workshop are to understand how modification of energy features during construction can affect compliance, to determine ”same or better” compliance status when energy features are changed during construction, and to understand the purpose and value of properly completed installation certificates.

Topics Addressed by this Training

- Understanding the Forms 1-2-3 (Quick Review)
  - Step 1 – Document What is Required with the CF1R
  - Step 2 – Document What is Installed with the CF2R
  - Step 3 – Document What is Verified with the CF3R
  - How the Forms Relate to Each Other (Quick Review)
- Forms That Will Commonly Be Used for Additions
  - CF1R Certificates of Compliance (at Submittal Phase)
  - CF2R Certificates of Installation (Prescriptive Approach)
  - CF3R Certificates of Verification (Prescriptive Approach)
- HERS Registry
  - Keeping Track of Revisions
  - Sampling vs. Not Sampling
- Regular Features vs. Special Features
  - Envelope: Regular Insulation vs. QII

    - Envelope: Mandatory Sealing vs. Reduced Infiltration
    - Mechanical: Minimum efficiency vs. High EER/SEER
    - Mechanical: Miscellaneous Credits
    - Water heating: Basic Systems vs. Special System Design
- Features Frequently Modified During Construction
    - Envelope: Window Areas and Orientations
    - Envelope: Miscellaneous Features
    - Mechanical: Equipment Size and Type
    - Mechanical: Duct Locations
    - Mechanical: Miscellaneous Features – Zonal Control
    - Water heating: Water Heater Quantity, Size, Type

Interpretation and Enforcement for Small Cities

Workshop 1: Prioritizing Plan Check and Field Inspection for Residential New Construction

Introduction

Plan checkers and field inspectors in building departments that serve smaller jurisdictions may need help prioritizing their review of energy code requirements. The 2013 Energy Code introduces new requirements, forms, and processes, which complicate this issue.

The goal of this training series is to provide building department staff with a focused, highly specific set of interpretations and enforcement strategies to improve energy code enforcement with residential new construction projects in small cities.

The learning objectives of this class are:

- Identify what 2013 compliance documentation is required on permit applications
- Determine which building features are most likely to affect energy code compliance
- Focus plan review and field verification efforts on most impactful building energy features

Topics Addressed by this Training

- Understanding the Forms 1-2-3
    - Step 1 – Document What is Required With the CF1R
    - Step 2 – Document What is Installed with the CF2R
    - Step 3 – Document What is Verified with the CF3R
    - 2008 Forms vs. 2013 Forms
- Compliance Process Flow Diagram
- What to Verify on a CF1R

- HERS Registry
    - Track the Status of Projects from Start to Finish
    - Keeping Track of Revisions
    - Accessing the HERS Registry
    - Your Online Energy Code Advisor: It's Automatic.

Workshop 2: Prioritizing Plan Check and Field Inspection for Nonresidential Low-Rise New Construction

Introduction

Plan checkers and field inspectors in building departments that serve smaller jurisdictions may need help prioritizing their review of energy code requirements. The 2013 Energy Code introduces new requirements, forms, and processes, which complicate this issue.

The goal of this training series is to provide building department staff with a focused, highly specific set of interpretations and enforcement strategies to improve energy code enforcement with nonresidential low-rise new construction projects in small cities.

The learning objectives of this class are:

- Identify what 2013 compliance documentation is required on nonresidential permit applications
- Determine which building features are most likely to affect energy code compliance
- Focus plan review and field verification efforts on most impactful building energy features

Topics Addressed by This Training

- The Nonresidential Compliance Process (Compared to Residential)
- What to Inspect on an NRCC-PRF-01
- Plan Check Checklist

Compliance Enhancement Strategies for Nonresidential Mechanical Systems

Workshop 1: Mechanical Ventilation and Outdoor Air—Improving Compliance

Introduction

Mechanical engineers, specialty contractors and installers working on nonresidential projects have been aware of the need to provide mandatory ventilation and outdoor air to occupied spaces for years. As ventilation systems have evolved over time, the industry has responded with more effective fresh air ventilation solutions, but the complexity of the new systems requires greater detail in the specification, installation and commissioning to ensure proper air

quality is maintained while balancing energy conservation needs at the same time. These challenges will be further complicated by the mechanical ventilation requirements in the 2013 energy code.

The goal for the BayREN 2013 Title 24 Part 6 Compliance Enhancement Strategies for Nonresidential Mechanical Systems training series is to provide building department staff, and the building professionals with whom staff interacts, with a focused, highly specific set of tools and strategies for enhancing energy code compliance for nonresidential mechanical systems.

The goal of this workshop is to provide a comprehensive overview of the ventilation and outdoor air requirements established under Title 24 Part 6 and guidelines for ensuring adequate ventilation is provided for nonresidential occupancies.

Topics Addressed by this Training

- Key Changes to Prescriptive Nonresidential Ventilation Requirements
    - Economizer Requirements
    - Occupant Sensor Ventilation Control Requirements
    - Ventilation Changes Due to Covered Processes
- Understanding the Forms 1-2-3 (Quick Review)
    - New Forms Naming Convention
    - 2013 Forms Structure
- When Ventilation is Required in Nonresidential Occupancies
- Alternative Outdoor Air Delivery Options
    - Outside Air Delivery Options
    - Transfer Air
    - Demand Control Ventilation (DCV)
    - Pre-Occupancy Purge Controls
- Spaces that Require No Mechanical Ventilation
    - Natural Ventilation
- Code Enforcement Best Practices

Workshop 2: Demand Control Ventilation—Improving Compliance

Introduction

Demand Control Ventilation (DCV) provides designers and contractors with an energy-efficient solution to provide outside air ventilation at measured levels based on occupant demand. DCV can also help maintain outdoor ventilation levels for intermittent occupant loads and reduce the need to heat or cool large volumes of outside air when it is not necessary. As new HVAC systems become more flexible, by including staged condenser operation and variable speed fans, the use of economizers and DCV systems will improve energy savings and occupant satisfaction.

The goal for the BayREN 2013 Title 24 Part 6 Compliance Enhancement Strategies for Nonresidential Mechanical Systems training series is to provide building department staff, and the building professionals with whom staff interacts, with a focused, highly specific set of tools and strategies for enhancing energy code compliance for nonresidential mechanical systems.

The goal of this workshop is to provide insight into common challenges associated with DCV in nonresidential buildings and provide options to improve compliance with these projects for nonresidential occupancies.

Topics Addressed by this Training

- Key Changes to Prescriptive Nonresidential Demand Control Ventilation Requirements
    - DCV Purpose, Methods, and Limitations
    - DCV Equipment Requirements
    - DCV Equipment Failures
    - DCV Exempt Locations
- Alternatives to DCV
    - Occupant Sensor Ventilation Controls
    - VAV Systems
    - Ventilation Systems
- Best Practices for Code Compliance
    - Certificate of Installation as a Field Checklist
    - Code Enforcement Best Practices

Compliance Enhancement Strategies: Nonresidential Lighting

Introduction

The goal for the BayREN 2013 Title 24 Part 6 Compliance Enhancement Strategies for Nonresidential Lighting training series is to provide building department staff, and the building professionals with whom staff interacts, with a focused, highly specific set of tools and strategies for enhancing energy code compliance for nonresidential lighting. Changes in the 2013 energy code to nonresidential lighting requirements add complexity to building projects and make it difficult to target key items that trigger code, prioritize plan check, and understand field inspection expectations.

Topics Addressed by This Training

- Parts of the Title 24 Energy Code and What They Mean
    - Prescriptive versus Performance
    - Overall Structure
    - Mandatory Requirements for Lighting Control Devices and Systems, Ballasts and Luminaires (§110.9, JA7 and 8)
    - Mandatory Requirements for Lighting Systems and Equipment (§130)

    - Prescriptive Requirements for Building Envelopes (Daylighting; §140.3)
    - Prescriptive Requirements for Indoor Lighting (Lighting Power Limits;§140.6)
    - Prescriptive Requirements for Outdoor Lighting (Lighting Power Limits; §140.7)
    - Prescriptive Requirements for Signs (§140.8)
    - Alterations, Additions and Repairs (§141.0)
- Changes from 2008 Standard to 2013 Standard
    - General
    - Mandatory Requirements
    - Daylighting
    - Lighting Power Allowances
    - Outdoor Lighting
    - Additions and Alterations
    - Special Note about LED Color
- Incentives
    - Savings By Design
    - Direct Incentives and Rebates
    - Custom Incentives and Rebates
    - Demand Response Incentives
    - Designers' Compliance Strategy
    - Renovations and Retrofits
    - Daylighting
    - Outdoor Lighting

12. Appendix C: BayREN-Developed Resources

Guides

A. Permit Guides

   a. Residential Water Heater Alteration (Replacement) Permit Guide

   b. Residential New or Replacement Windows Permit Guide

   c. Residential Re-Roofing Permit Guide

   d. Nonresidential Re-Roofing Permit Guide

B. Quick Reference Guides

   a. Gas Hot Water Heater Guide

C. Building Science Guides

   a. Cool Roofs and Radiant Barriers

   b. Verifying Energy Efficiency Requirements

   c. Residential Mechanical Ventilation

Compliance Enhancement Tools

A. Compliance Process Flow Chart

B. What to Inspect on an NRC-PRF-01

C. What to Inspect on a CF1R Form

D. What to Inspect on a CF2R-ENV-01, 02, 03 Form

Residential Water Heater Alteration

2013 Energy Code Permit Guide

Permit DATE: Permit NUMBER: CA Climate Zone:

Permit ADDRESS: City, Zip:

This guide applies to: Storage gas water heaters with an input rating ≤ 75,000 Btu per hour; Instantaneous gas water heaters with an input rating ≤ 200,000 Btu per hour; and Electric water heaters. For other water heating system types and configurations refer to section 150.2(b) of the *2013 Building Energy Efficiency Standards*.

WATER HEATER REPLACEMENT:

What is the fuel type of the replacement water heater?

- ☐ Natural gas or LPG/propane
- ☐ Electric Resistance (Allowed only if this is also the existing fuel type)

WATER HEATER ADDITION:

Is more than one water heater being added?

- ☐ No
- ☐ Yes (Performance approach must be used)

What is the fuel type of the additional water heater?

- ☐ Natural gas or LPG/propane
- ☐ Electric Resistance (Allowed only if this is also the existing fuel type)

TANK INSULATION:

Is the Energy Factor of the water heater greater than 0.58?

- ☐ Yes
- ☐ No, it is exactly 0.58. Minimum R12 external tank insulation must be installed
- ☐ Not applicable, no storage tank exists

PIPE INSULATION:

The following pipes must have at least one inch of insulation, if pipes are accessible

- ☐ First five feet of hot and cold water pipes from the storage tank
- ☐ Hot water pipes between the water heater and kitchen

RECIRCULATION SYSTEMS:

Are you replacing a recirculation pump?

- ☐ No, no recirculation system exists
- ☐ No, but a recirculation system already exists. Accessible pipes within an existing loop must be insulated at the time of the water heater replacement
- ☐ Yes. Demand recirculation systems with manual control pumps must be used and all pipes must be insulated

Is a recirculation system being added?

- ☐ No
- ☐ Yes (Performance approach must be used)

Required Form:

- CF1R-ALT-01-E: Certificate of Compliance, Residential Alterations

For more information on 2013 Title 24 Part 6 requirements:

- Visit the CEC website: **www.energy.ca.gov/title24/2013standards/**
- Contact the CEC energy code hotline at (800) 772-3300 or email: **title24@energy.state.ca.us**
- Contact the BayREN Codes & Standards Program by email: **codes@bayren.org**

BAY AREA Regional Energy Network

Residential New or Replacement Windows (Fenestration)

2013 Energy Code Permit Guide

Fenestration includes windows, skylights, and doors with ≥ 50% glazed area

Permit DATE: Permit NUMBER: Climate Zone:

Permit ADDRESS: City, Zip:

REPLACEMENT or MINOR ADDITION of WINDOWS:

Are you increasing the total fenestration area by more than 75 ft^2?

- ☐ Yes (skip to NEW WINDOWS)
- ☐ No (circle the applicable requirements in the table)

Are you adding more than 16 ft2of skylight area?

- ☐ Yes (skip to NEW WINDOWS)
- ☐ No (circle the applicable requirements in the table)

NEW WINDOWS:

Is the total fenestration area (existing plus new) less than or equal to 20% of conditioned floor area?

- ☐ Yes (circle the applicable requirements in the table)
- ☐ No (performance approach must be used)

Is the total area of West-facing fenestration (existing plus new) less than or equal to 5% of conditioned floor area? (Does not apply to Climate Zone 3)

- ☐ Yes (circle the applicable requirements in the table)
- ☐ No (performance approach must be used)

Residential Fenestration Requirements, 2013 Energy Code NR = No Requirement

	CZ 2	CZ 3	CZ 4	C Z 12	New Skylights (up to 16 ft^2)	Replacement Windows (up to 75 ft^2)
Maximum U-Factor	0.32	0.32	0.32	0.32	0.55	0.40
Maximum SHGC	0.25	NR	0.25	0.25	0.30	0.35

Building Inspector:

Each new or replacement fenestration product must have a National Fenestration Rating Council (NFRC) Label whose values correspond to the table above; area-weighted average values may be used. Reference the signed and registered CF1R-ENV-01-E Fenestration Installation Certificate. If values are area-weighted averages, also reference the signed and registered CF1R-ENV-02-E Area Weighted Average Calculation Worksheet.

Required Forms:

- CF1R-ALT-01-E: Certificate of Compliance, Non-HVAC Residential Alterations
- CF2R-ENV-01-E: Fenestration Installation Certificate (from installing contractor, before field inspection)

If Applicable:

- CF1R-ENV-02-E: Area Weighted Average Calculation Worksheet

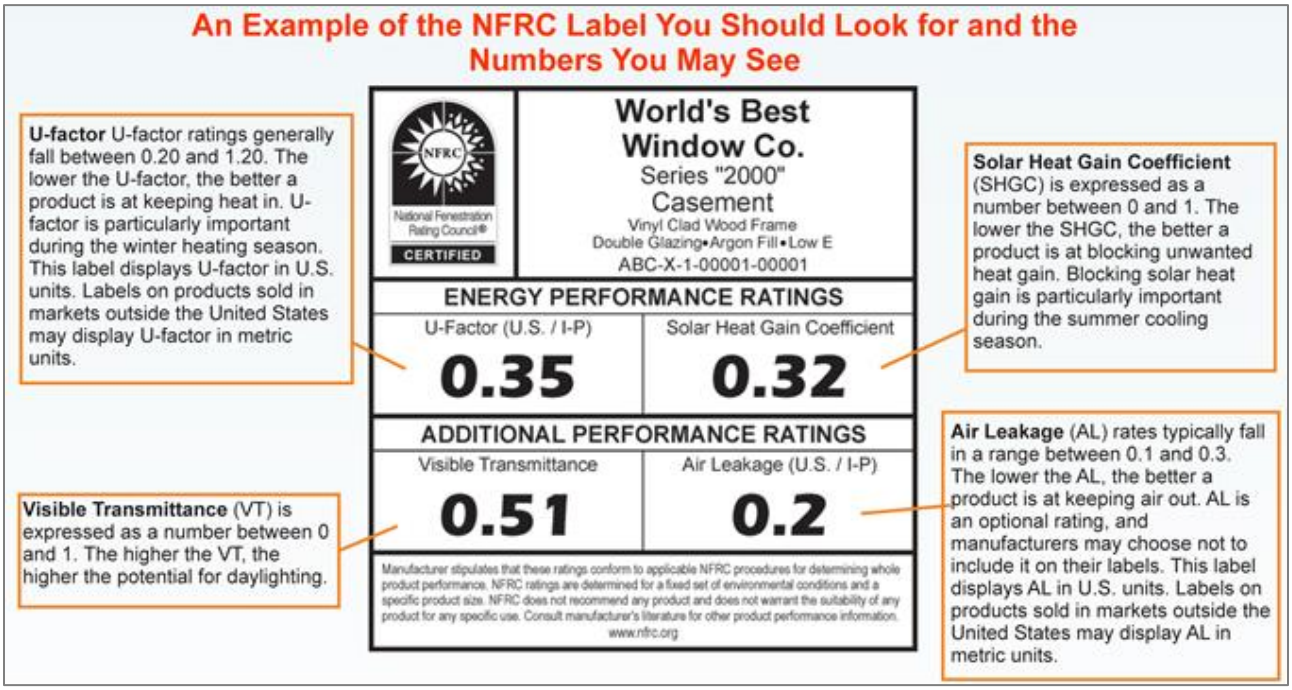
BAY AREA Regional Energy Network

Residential New or Replacement Windows (Fenestration)

2013 Energy Code Permit Guide

For more information on 2013 Title 24 Part 6 requirements:

- Visit the CEC website: **www.energy.ca.gov/title24/2013standards/**
- Visit the NRFC website: **www.NFRC.org**
- Contact the CEC energy code hotline at (800) 772-3300 or email: **title24@energy.state.ca.us**
- Contact the BayREN Codes & Standards Program by email: **codes@bayren.org**



BAY AREA Regional Energy Network

Residential Re-Roofing

2013 Energy Code Permit Guide

Permit Issue DATE: Permit NUMBER: CA Climate Zone: **12**

Permit ADDRESS: City, Zip:

COOL ROOF IS NOT REQUIRED if any of the boxes below are checked.

Cool Roof Exemptions: Check any that apply.

- ☐ Roof pitch is less than 2:12
- ☐ Area to be re-roofed is less than 50% of total roof area
  Area to be re-roofed = _____ ft^2 Total roof area = _____ ft^2

Cool Roof Alternatives: Check any that apply.

- ☐ There is an attic radiant barrier
- ☐ There are NO ducts in the attic
- ☐ Ducts in the attic have been HERS-verified to be sealed to ≤ 6% leakage and insulated to ≥ R-6
- ☐ There is at least R-38 ceiling insulation
- ☐ There is at least R-4 insulation above the roof deck
- ☐ The installed roofing product has a profile ratio of rise to width of 1 to 5 for 50 percent or greater of the width of the roofing product
- ☐ There is at least a 1.0 inch air-space between the top of the roof deck and the bottom of the roofing product

COOL ROOF IS REQUIRED if none of the boxes above are checked. Circle applicable requirements in the Table.

Prescriptive Requirements for COOL ROOFS Does not apply to roof area covered by building-integrated photovoltaic (PV) and building-integrated solar thermal panels.

		BayREN Climate Zone	**12**
Roof pitch > 2:12	3 year Aged Solar Reflectance, minimum		0.20
	AND Thermal Emittance, minimum		0.75
	OR Solar Reflective Index (SRI), minimum (This value must be calculated, see below)		16

Building Inspector:

Roofing material must have a Cool Roof Rating Council (CRRC) package label indicating compliance with the requirements in the table above. See page 2 of this guide for an example of a CRRC label, and instructions for calculating Aged Solar Reflectance and Solar Reflective Index.

Required Forms:

- CF1R-ALT-01-E: Certificate of Compliance – Res Alterations (from contractor or owner)
- CF2R-ENV-05-E: Certificate of Installation – Cool Roof (from installing contractor to building department)
- CRRC label specifying Initial and Aged Solar Reflectance, and Thermal Emittance

If SRI value is used:

- CF1R-ENV-04-E: Solar Reflective Index Calculation Worksheet

Residential Re-Roofing

2013 Energy Code Permit Guide

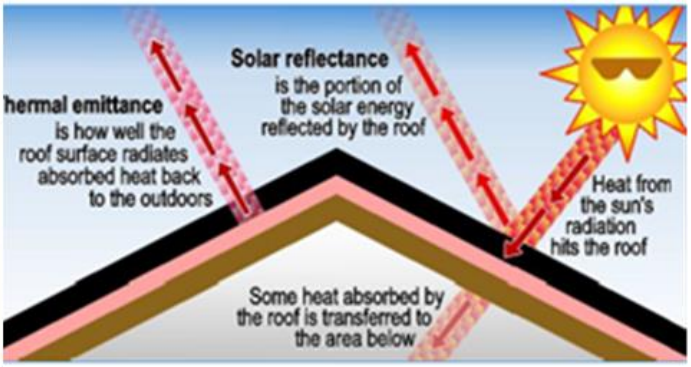
Explanation from the 2013 Title 24 Residential Compliance Manual:

- Complying products are labeled by the Cool Roof Rating Council (CRRC, **www.coolroofs.org**)
- CRRC label values for installed roofing products must meet or exceed T24 code requirements
- Solar Reflectance Index can be used instead of Aged Solar Reflectance and Thermal Emittance. To calculate Solar Reflectance Index, go to: **www.energy.ca.gov/title24/2013standards**

Information from the Cool Roof Rating Council website

www.coolroofs.org/resources/california-title-24

California's Title 24 Building Energy Efficiency Standards establish minimum prescriptive values for 3-year Aged Solar Reflectance, Thermal Emittance, and Solar Reflectance Index. Requirements for residential buildings are limited to specific climate zones; in those climate zones they apply to all new construction, additions of at least 300 ft^2 and alterations that replace over 50% of the roof surface. There are numerous exceptions to these cool roofing requirements, such as for low slope roofs (pitch ≤ 2:12), roof areas covered by building-integrated photovoltaic panels, and roofs with thermal mass greater than 25 lbs/ft^2 over the roof membrane (green roofs).



Changes from 2008 Energy Code:

- Distinctions between roofing product weight (more or less than 5 lbs/ft^2) have been removed
- The equation for calculating Aged from Initial Solar Reflectance was updated
- For residential alterations, an exception for increased roof insulation

For more information on 2013 Title 24 Part 6 requirements:

- Visit the CEC website: **www.energy.ca.gov/title24/2013standards/**
- Contact the CEC energy code hotline at (800) 772-3300 or email: **title24@energy.state.ca.us**
- Contact the BayREN Codes & Standards Program by email: **codes@bayren.org**

BAY AREA Regional Energy Network

Nonresidential Re-Roofing
2013 Energy Code Permit Guide

Permit DATE: Permit NUMBER: CA Climate Zone:

Permit ADDRESS: City, Zip:

COOL ROOF IS NOT REQUIRED If any of the boxes below are checked.

Cool Roof Exemptions: Check any that apply.

- ☐ Roof area is over unconditioned space (e.g. warehouse) or process space (e.g. manufacturing)
- ☐ Area to be re-roofed does not exceed 2,000 ft^2 OR 50% of total roof area, whichever is greater
  Area to be re-roofed = _____ ft^2 Total roof area = _____ ft^2

Cool Roof Exceptions: Check any that apply.

- ☐ In CZ 3, wood-framed roof has a U-factor ≤ 0.039
- ☐ In CZ 3, metal building roof has a U-factor ≤ 0.048
- ☐ Roof constructions that have thermal mass with a weight of ≥ 25 lb/ft^2 over the roof membrane

COOL ROOF IS REQUIRED If none of the boxes above are checked.

Table 1. Prescriptive Requirements for COOL ROOFS Circle the applicable requirements.

*Solar Reflective Index values must be calculated, see Page 2 of this guide.

Nonresidential Buildings		
Low-sloped roof pitch ≤ 2:12	3 year Aged Solar Reflectance, minimum	0.63
	AND Thermal Emittance, minimum	0.75
	OR Solar Reflective Index, minimum*	75
Steep-sloped roof pitch > 2:12	3 year Aged Solar Reflectance, minimum	0.20
	AND Thermal Emittance, minimum	0.75
	OR Solar Reflective Index, minimum*	16
Hotel, Motel, and High-rise Residential Buildings		
Steep-sloped roof pitch > 2:12 All roof weights	3 year Aged Solar Reflectance, minimum	0.20
	AND Thermal Emittance, minimum	0.75
	OR Solar Reflective Index, minimum*	16

Optional: For nonresidential buildings with low-sloped roofs, the 2013 code allows a tradeoff between increased roof/ceiling insulation and reduced Aged Solar Reflectance values. To use this option, circle the actual U-factor of the building's roof/ceiling assembly in Table 2, and the corresponding minimum Aged Solar Reflectance value.

Table 2. Tradeoff Values for Aged Solar Reflectance Circle the applicable requirements.

Roof/Ceiling Insulation Tradeoffs		
Aged Solar Reflectance	Metal Building U-factor	Other Building Types U-factor
0.62-0.60	0.061	0.036
0.59-0.55	0.054	0.034
0.54-0.50	0.049	0.032
0.49-0.45	0.047	0.030
0.44-0.40	0.043	0.028
0.39-0.35	0.039	0.027
0.34-0.30	0.035	0.025
0.29-0.25	0.033	0.024

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Nonresidential Re-Roofing
2013 Energy Code Permit Guide

ROOF INSULATION IS NOT REQUIRED if any of the boxes below are checked.

Exception to Roof Insulation Requirements: Check any that apply.

- ☐ Existing roof is already insulated to at least R-7 or has a U-factor less than 0.089
- ☐ The roof is not exposed to the roof deck or roof recover boards
- ☐ If mechanical equipment is located on the roof and will not be disconnected and lifted as part of the roof replacement, see Section 141.0(b)2Biii of the *2013 Building Energy Efficiency Standards*

ROOF INSULATION IS REQUIRED if none of the boxes above are checked.

Table 3. Mandatory Insulation Requirements for Roof Alterations Circle the applicable requirements.

	BayREN Climate Zone	2	3	4	12
Nonresidential Buildings	Continuous insulation R-value / Roof assembly U-factor	R-14 / 0.055	R-8 / 0.082	R-8 / 0.082	R-14 / 0.055
High-rise Residential & Guest Rooms of Hotel/Motel Buildings	Continuous insulation R-value / Roof assembly U-factor	R-14 / 0.055	R-14 / 0.055	R-14 / 0.055	R-14 / 0.055

Building Inspector: Roofing material must have a Cool Roof Rating Council (CRRC) package label indicating compliance with the requirements in the table above. If re-roofing involves a field applied liquid coating, see Section 110.8(i)4, Table 110.8-C of the *2013 Building Energy Efficiency Standards*.

Required Forms:

- NRCC-ENV-02-E: Certificate of Compliance for Envelope Component
- NRCI-ENV-01-E: Certificate of Installation for Envelope (from installing contractor, before field inspection)
- Cool Roof Rating Council (CRRC) label indicating compliance with applicable requirements

If Applicable:

- NRCC-ENV-03-E: Solar Reflectance Index Calculation Worksheet
  (if this value is used instead of Aged Solar Reflectance and Thermal Emittance values)

For more information on 2013 Title 24 Part 6 requirements:

- Visit **www.energy.ca.gov/title24/2013standards/**
- Contact the energy code hotline at (800) 772-3300 or email: **title24@energy.state.ca.us**
- Contact the BayREN Codes & Standards Program by email: **codes@bayren.org**

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Quick Reference Guide for Gas Water Heaters

This guide is intended to serve as a quick reference for building inspectors and contractors. Systems installed per these requirements will comply with the pertinent sections of the 2013 Building Energy Efficiency Standards (Title 24, Part 6 of the California Building Standards Code).

System	Minimum Required Efficiency[1]										
Water Heater Type	**Efficiency Formula[2,3]**	**30 Gal**	**35 Gal**	**40 Gal**	**45 Gal**	**50 Gal**	**55 Gal**	**60 Gal**	**65 Gal**	**70 Gal**	**75 Gal**	**80 Gal**
Manufactured Before April 16, 2015												
Storage Gas water Heater (≤ 55 gallons & ≤ 75,000 Btu Input), Efficiency Expressed as Energy Factor (EF)	0.67 - (0.0019 * V)	0.613	0.604	0.594	0.585	0.575	0.565	N/A	N/A	N/A	N/A	N/A
Storage Gas water Heater (> 55 gallons & ≤ 75,000 Btu Input) Efficiency Expressed as Energy Factor (EF)	0.67 - (0.0019 * V)	N/A	N/A	N/A	N/A	N/A	N/A	0.556	0.547	0.537	0.528	0.518
Storage Gas water Heater (> 75,000 Btu Input) Efficiency Expressed as Thermal Efficiency (TE)	Must Use Performance Approach to Compliance											
Tankless Gas (≤ 200 kBtu input) Efficiency Expressed as Energy Factor (EF)	0.62											
Manufactured After April 16, 2015												
Storage Gas water Heater (≤ 55 gallons & ≤ 75,000 Btu Input) Efficiency Expressed as Energy Factor (EF)	0.675 - (0.0015 * V)	0.63	0.623	0.615	0.608	0.6	0.593	N/A	N/A	N/A	N/A	N/A
Storage Gas water Heater (> 55 gallons & ≤ 75,000 Btu Input) Efficiency Expressed as Energy Factor (EF)	0.8012 - (0.00078 * V)	N/A	N/A	N/A	N/A	N/A	N/A	0.754	0.751	0.747	0.743	0.739
Storage Gas water Heater (> 75,000 Btu Input) Efficiency Expressed as Thermal Efficiency (TE)	Must Use Performance Approach to Compliance											
Tankless Gas (≤ 200 kBtu input) Efficiency Expressed as Energy Factor (EF)	0.82											

Compliance Approach	How to Verify Efficiency
Prescriptive	Verify manufacture date to determine minimum required efficiency. Installed unit must meet or exceed this requirement. Manufacture date and efficiency are typically listed on the equipment label. If the information is not listed on the label, BayREN suggests that the installing contractor provide the inspector proof that the water heater meets the minimum efficiencies either through the CEC website or AHRI database.
Performance	Check the CF1R to determine minimum required efficiency. Manufacture Date and efficiency are typically listed on the equipment label. If the information is not listed on the label, BayREN suggests that the installing contractor provide the inspector proof that the water heater meets the minimum efficiencies either through the CEC website or AHRI database.

[1] Projects demonstrating compliance using the performance approach may require a higher efficiency than the minimums stated here. When this occurs, the efficiency listed on the CF1R-PRF-01 is the required efficiency.
[2] Appliance Efficiency Regulations are governed by California Building Code Title 20. Efficiencies listed above have been adapted from the 2014 Appliance Efficiency Regulations §1605.1(f), Table F-3.
[3] For water heater systems that serve individual dwelling units, the standard design (Package A) is a 50 gallon gas storage water heater with an Energy Factor equal to the federal minimum standard, per the 2013 Residential Compliance Manual, §8.3.1.

System	Mandatory Pipe Insulation Requirements[4]				
Water Heater Attributes	**All Hot water pipes from source to kitchen fixtures**	**All hot water pipes ≥ 3/4" diameter**	**Hot water pipe buried below grade (waterproof non-crushable casing required)**	**Hot and cold water pipes insulated for first 5ft from water heater (conditioned or unconditioned space)**	**Entire hot water length insulated, all sections, buried pipe or exposed pipe**
Standards Section	§150.0(j)(2)(A)	§150.0(j)(2)(A)	§150.0(j)(2)(A)(B)	§150.0(j)(2)(A)	§150.0(j)(2)(A)
Pipe Diameter ≤ 1"	**Insulation Thickness**				
Non-recirculating distribution system	1”	1”	1”	1”	N/A
Recirculating distribution system	1”	1”	1”	1”	1”
Pipe Diameter > 1"	**Insulation Thickness**				
Non-recirculating distribution system	1.5”	1.5”	1.5”	1.5”	N/A
Recirculating distribution system	1.5”	1.5”	1.5”	1.5”	1.5”

Standards Section	Mandatory Plumbing Requirements for New Construction and Additions with New Gas Storage Water Heater (to accommodate future installation of tankless water heater)
§150.0(n)(1)(A)	1. A 120V electric receptacle that is within 3 feet from the water heater and accessible to the water heater with no obstructions, and
§150.0(n)(1)(B)	2. A Category III or IV vent, or a Type B vent with straight pipe between the outside termination and the space where the water heater is installed, and
§150.0(n)(1)(C)	3. A condensate drain that is no more than 2 inches higher than the base of the installed water heater, and allows natural draining without pump assistance, and
§150.0(n)(1)(D)	4. A gas supply line with a capacity of at least 200,000 Btu/hr.

Procedure(s)	HERS Verified Measure Credits[5]
RA3.6.3	1. Verified Pipe Insulation Credit (PIC-H)
RA3.6.4	2. Verified Parallel Piping (PP-H)
RA3.6.5	3. Verified Compact Hot Water Distribution System (CHWDS-H)
RA3.6.6	4. Verified Point of USE (POU-H)
RA3.6.7	5. Demand Recirculation: Manual Control (RDRmc-H)
RA3.6.8	6. Demand Recirculation: Sensor Control (RDRsc-H)

[4] Insulation thickness requirements can be found in the energy code §120.3, Table 120.3 A.

[5] For projects claiming credit for HERS Verified Measures listed above, the credits will be listed on the CF1R-PRF-01. For those measures, the building inspector should confirm that all appropriate information and signatures are contained in the CF2R/3R-PLB-22H. All other water heater requirements must still be met.

Cool Roofs and Radiant Barriers

Cool roofs and radiant barriers are relatively new energy code measures for residential buildings. The purpose of this guide is to explain what they do, how they work, differences between them, when they are required, and how they will be verified by building departments. The guide is intended to help designers, builders, contractors, inspectors, and anyone involved in improving comfort, lowering energy costs and improving the energy efficiency of California homes.

The 2013 Building Energy Efficiency Standards provide the following definitions:

1. **COOL ROOF** is a roofing material with high thermal emittance and high solar reflectance, or low thermal emittance and exceptionally high solar reflectance that reduces heat gain through the roof. Cool roofs are a prescriptive requirement for new residences in California's Climate Zone 12 (but not in 02, 03 or 04) for steep sloped roofs that are not heavy stone or tile. For alterations in Climate Zone 12, cool roofs are required in many cases, unless one of the exceptions is met.
2. **RADIANT BARRIER** is a highly reflective, low emitting material installed at the underside surface of the roof deck and the inside surface of gable ends or other exterior vertical surfaces in attics to reduce solar heat gain. Radiant barriers are a prescriptive requirement in the Bay Area for new residences, and in certain cases are also required for alterations.

Building Science Principles

Even in new homes, much of the heat gain in summer and heat loss in winter occurs at the ceiling level. Attic insulation reduces conductive heat flow, but heat also moves by convection, or airflow, through gaps in the attic floor, and by radiant heat transfer through materials. Reducing attic heat gain during summer is especially important for homes with heating and cooling equipment and ductwork located in the attic, because ductwork contains and distributes conditioned indoor air.

Solar Reflectance and Thermal Emmitance

Reflectivity (or reflectance) is a measure of how much energy is reflected by a material at a given wavelength. It is expressed as a number between zero and one. The higher the reflectivity of a roofing material, the more of the sun's radiation will be reflected, and the less will be absorbed as heat.

Emissivity (or emittance) is the ability of an object's surface to emit absorbed heat back into air, and the object must be adjacent to an air space to do so. It also is expressed as a number between zero and one. The higher the emissivity of a material, the more readily it emits heat, and the lower the emissivity, the less heat it emits.

Heat Transfer

Conduction is the transfer of heat between objects in physical contact with each other. In buildings, insulation slows conduction between solids.

Convection is the transfer of heat by the movement of a liquid or gas - usually air or water. In buildings, air barriers are solid materials that stop airflow between indoors and out, and must be continuous to be effective.

Radiation is the line-of-sight transfer of heat/energy between solid materials via electromagnetic waves.

The sun radiates heat in the form of electromagnetic energy that travels through space until it encounters solid objects, including rooftops. Radiant heat that strikes a roof is either reflected back into the air or absorbed by the roofing material, increasing its temperature. Heat absorbed at the roof's surface flows by conduction through all solid roofing materials until it encounters an air space, usually the attic. The underside of the roof sheathing, which is now hot, then radiates or emits its heat into the attic air space, where it is absorbed by solid objects in the attic, including any ductwork.

Cool Roof and Radiant Barrier Design Elements

Cool roof materials have high reflectivity and emissivity. Cool roofs are available in a range of colors (including dark colors) and materials, including composite, metal and tile. The rated performance of a certified cool roof product can be obtained from the Cool Roof Rating Council's (CRRC) website: www.coolroofs.org.

Radiant barriers are also highly reflective, but have low emissivity. For building construction, a reflective material such as aluminum foil is typically adhered to more durable sheet material, such as plywood or OSB sheathing, plastic, or sturdy paper. To be effective, the shiny, reflective side of the radiant barrier material must face the attic open air space; otherwise, the foil conducts heat between solids instead of stopping its flow.

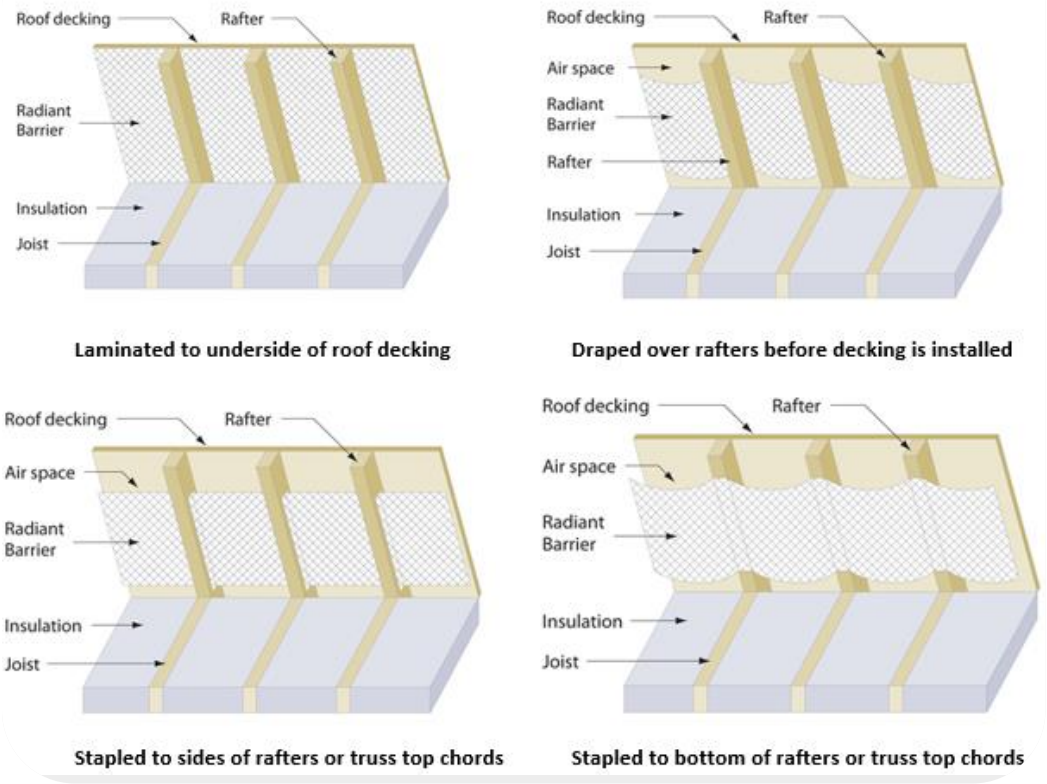
Best Practice Design

Best practice dictates that cool roofs and radiant barriers be utilized where prescriptively required by the building code. In many cases, it is cost effective to exceed minimum code requirements, particularly in hotter climates, because they can substantially lower energy costs in buildings.

Performance Method

- Products that are required prescriptively but perform better than the prescriptive requirements will yield a credit on the performance run, improving a building's compliance margin.
- Products that are required prescriptively and perform worse that the prescriptive requirements will yield a penalty on the performance run, decreasing a building's compliance margin.
- Products that are not required prescriptively but are included in the design in warmer climate zones will likely yield a credit on the performance run, improving a building's compliance margin.

Radiant Barrier Installation Options [1]



Prescriptive Requirements for New Additions and Alterations

Cool roofs are a prescriptive requirement in Climate Zone 12 for residential buildings with steep sloped roofs (pitch > 2:12) and lightweight roofing material (< 25 lb/ft2). In these buildings, cool roofing products must have an aged solar reflectance of at least 0.20 and thermal emittance of at least 0.75, or a solar reflective index of at least 16.[2]

Radiant barriers are a prescriptive requirement in all new low-rise residential buildings in Climate Zones 02 through 15, which includes all Bay Area climate zones (02, 03, 04, and 12). Radiant barriers installed to meet the prescriptive requirements in California homes must have an emittance of 0.05 or less.[3] Radiant barriers must also cover all vertical surfaces in the attic that are adjacent to outdoors, including gable end walls. In addition, attics must meet ventilation requirements.[4]

Requirements for Alterations

Because of the wide variety of building permit scenarios represented in the alteration category it is best to consult the Residential Compliance Manual for specific requirements with regard to cool roofs and radiant barrier applicability. The general principle for alterations is 'if you touch it, bring it up to code'.

Building Department Inspections

Because cool roof materials cannot be verified by visual inspection, installers must provide inspectors with the CRRC label from the roofing material packaging. Inspectors should compare and verify that aged solar reflectance and emittance – or solar reflective index (SRI) - meet or exceed requirements; higher values are better.

When radiant barriers are required, inspectors should verify their presence, proper installation, and continuity. Radiant barriers laminated to the underside of roof decking are the easiest for building inspectors to verify by visual inspection. The continuity and air space requirements of radiant barriers draped over or stapled to trusses/rafters are more difficult to verify. Inspectors should also verify that a radiant barrier covers all vertical attic surfaces that are adjacent to outdoors.

Building inspectors will review the CF2R-ENV-04-E, Certificate of Installation. If a HERS-verified measure is used in lieu of a radiant barrier or cool roof, then the associated HERS inspection, test and registered forms must also be provided.

1. Image source: Oak Ridge National Laboratory
2. 2013 Building Energy Efficiency Standards §150.1(c)11
3. 2013 Building Energy Efficiency Standards §150.1(c)2
4. Appendix RA4.2.1.1

Verifying Energy Efficiency Requirements

This quick reference guide is for building inspectors and contractors following the 2013 Building Energy Efficiency Standards (Title 24, Part 6). These minimum energy efficiency requirements of common building components apply to single family residential new construction in Bay Area Climate Zones 02, 03, 04, and 12.

Abbreviations and Acronyms

AHRI	Air-Conditioning, Heating, And Refrigeration Institute	**HERS**	Home Energy Rating System
AT	Airtight	**HSPF**	Heating Season Performance Factor
CEC	California Energy Commission	**IC**	Insulation Contact
CFA	Conditioned Floor Area	**LED**	Light Emitting Diode
CFL	Compact Fluorescent Lamp	**NFRC**	National Fenestration Rating Council
CRRC	Cool Roof Rating Council	**mfd/mfr**	Manufactured/Manufacturer
CZ	California Climate Zone	**RCM**	Residential Compliance Manual (Title 24, Part 6)
EER	Energy Efficiency Ratio	**SEER**	Seasonal Energy Efficiency Ratio
EF	Energy Factor	**SHGC**	Solar Heat Gain Coefficient

Minimum Energy Efficiency Requirements

Component	Minimum Requirement	2013 Standards Section(s)	How to Verify Efficiency of Installed Components
Building Envelope			
Ceiling/attic insulation	CF1R value or R-30, whichever is higher.	§150.0(a-d) RCM 3.9.6	For batts/blankets use R-value on packaging; For rigid sheets use R-value on product; For loose-fill insulation, compare installed depth/thickness with mfr specs on product packaging; For spray polyurethane foam use RCM Table 3-10.
Exterior wall cavity insulation	CF1R value or R-13 with 2x4 framing, R-19 with 2x6 framing, whichever is higher.	§150.0(a-d) RCM 3.9.6	
Exterior wall total insulation	CF1R value.	§150.0(a-d) RCM 3.9.6	
Raised floor insulation	CF1R value or R-19, whichever is higher.	§150.0(a-d) RCM 3.9.6	
Duct insulation (except those in conditioned space)	CF1R value or mandatory R-6, whiche ver is higher.	§150.0(m)4 110.8	R-value printed on outside of insulated flex duct.
Window U-factor	CF1R value.	Table 150.1-A	NFRC labels on installed products.
Skylight U-factor	CF1R value.	§150.0(q)	NFRC labels on installed products.
Window SHGC	CF1R value.	Table 150.1-A	NFRC labels on installed products.
Skylight SHGC	CF1R value.	Table 150.1-A	NFRC labels on installed products.
Cool roofing products	CF1R values.	Table 150.1-A	CRRC labels on roofing material packaging.

Component	Minimum Requirement	2013 Standards Section(s)	How to Verify Efficiency of Installed Components
Building HVAC			
Central air conditioners - split systems <45,000 Btu/h	CF1R values or SEER 14/EER 12.2, whichever are higher. HERS verification is required for higher-than-minimum values.	RCM Table 4-6	Obtain AHRI Certificate from installing contractor and compare AHRI equipment efficiency to those on the CF1R. If the CF1R shows higher-than-prescriptive values, collect a CF3R-MCH-26-H form from HERS rater.
Central air conditioners - package systems <45,000 Btu/h	CF1R values or SEER 14/EER 11.0, whichever are higher. HERS verification is required for higher-than-minimum values.	RCM Table 4-6	
Central air-source heat pumps, <65,000 Btu/h cooling capacity - heating efficiency	CF1R value or 8.0 HSPF for packaged systems, 8.2 HSPF for split systems, whichever is higher. HERS verification is required for higher-than-minimum values.	Table 150.1A RCM 4.2.1.2 RCM Table 4-3	
Central air-source heat pumps, <65,000 Btu/h cooling capacity - cooling efficiency	CF1R or 14 SEER for split systems, whichever is higher. HERS verification is required for higher-than-minimum values.	Table 150.1A RCM 4.3.1 RCM Table 4-6	
Whole-house fan	CF1R indicates whether it is required. If listed on CF1R, fans must move ≥ 2 cfm/ft2 CFA, and attic has required free vent area.	§150.1(c)12	Verify fan is listed in CEC Appliance Directory, and that it moves ≥ 2 cfm /ft^2 CFA, and attic has ≥ one ft^2 net free vent area per 375 cfm of WHF airflow.
Local bathroom and kitchen exhaust fans	Mandatory: Energy Star labeled.	§150.0(o) RCM Chapter 4	Verify Energy Star labels on the fan housing or product box.
Water Heating			
Gas storage water heaters, ≤ 55 gallons and 75 kbtu/hr input	CF1R value or mandatory Energy Factor, whichever is higher: If mfd before April 16, 2015, mandatory: EF ≥ 0.67-(0.0019 x V). If mfd after April 16, 2015, mandatory: EF ≥ 0.675 - (0.0015 x V).	§110.1 §110.3 §150.1(c)8A RCM Table 5-1	Enter model no. from appliance nameplate into CEC Appliance Database and find equipment EF. Installed EF must be ≥ EF listed on CF1R.
Gas tankless water heaters, ≤ 200 kbtu/hr input	CF1R value or mandatory Energy Factor, whichever is higher: If mfd before April 16, 2015, mandatory: EF ≥ 0.62. If mfd after April 15, 2015, mandatory: EF ≥ 0.82.	§150.1(c)8B RCM Table 5-1	
Water pipe insulation	For DHW systems with water temperatures 105-140°F, mandatory ≥ one inch insulation on pipes ≤ one inch diameter, and ≥ 1.5 inches insulation on pipes over one inch diameter.	§120.3(a) Table 120.3-A §150.0(j)2 RCM 5.3.4	Verify that pipes have the required thickness of insulation for the pipe diameter.
Lighting			
Luminaires recessed in insulated ceilings	Mandatory: must be rated for zero clearance IC, certified AT, and be gasketed or caulked between the housing and ceiling.	RCM 3.8.1.J	Inspect luminaire housing for IC and AT labels, and adequate air sealing.

Residential Mechanical Ventilation, Build Tight and Ventilate Right

Mechanical ventilation is a code requirement that is necessary for occupant health and ensures acceptable indoor air quality in tighter, more energy efficient homes. This guide is intended to help contractors understand mechanical ventilation requirements and design strategies in order to comply with the 2013 Building Energy Efficiency Standards (Title 24, Part 6 of the California Building Standards Code). It will also help homeowners, contractors, and building department staff understand why these requirements were adopted and how they will be enforced. "Build Tight, Ventilate Right" is the building science principle behind this guide.

California's 2013 Building Energy Efficiency Standards have mandatory requirements for two ventilation functions:

1. Local exhaust fans in bathrooms and kitchens, for removing excess moisture and odors at their source, and
2. Whole-building ventilation systems (including individual dwelling units in low-rise multifamily buildings), for ensuring an adequate supply of outdoor air when windows are closed.[1]

These requirements apply to **all new single-family homes, homes with additions greater than 1,000 ft^2, and multifamily homes in buildings of three stories or less**.[2] Local exhaust fan requirements also apply in most alterations and additions.[3]

Local Exhaust Fans

Codes have required exhaust fans for decades, but poor quality fans, controls and installation practices have limited their use, and therefore their effectiveness. As home construction becomes tighter, consistent and effective use of these fans become even more important for good indoor air quality. Excess indoor moisture compromises indoor air quality by supporting the growth of mold, dust mites, and other sources of allergens.

- The most effective way to control indoor moisture is to use bathroom exhaust fans as needed during and after bathing or showering.
- In kitchens, excess moisture and odors from cooking need to be removed by an exhaust fan, typically located inside the range hood.

Relative Humidity

Relative humidity (RH) is the degree to which air is saturated with moisture, expressed in percent. Indoor relative humidity should be kept below 60% because higher levels support the growth of mold and mildew.

A **humidistat** measures RH, and automatically turns an exhaust fan on or off in response. For best results, set the humidistat to 50% RH - the fan will operate automatically when RH exceeds 50%, and turn off automatically when RH drops below 50%.

Minimum Local Exhaust Requirements

A local exhaust fan is required in every room that has cooking appliances, and every room that has a shower, bathtub or spa, and all fans must be ducted directly to the outdoors. California's green building code (Title 24 Part 11) requires that local exhaust fans be Energy Star labelled, and bathroom fans that are not part of a whole-building ventilation system must be controlled by a humidistat that is adjustable from 50-80% RH. The humidistat is usually located on the fan housing.[4]

- Intermittently operated bathroom exhaust fans must move at least 50 cfm of air.
- Continuously operated bathroom exhaust fans must move at least 20 cfm of air.
- Intermittently operated kitchen range hood exhaust fans must move at least 100 cfm of air.
- Continuously operated exhaust fans elsewhere in the kitchen must provide at least 5 air changes per hour (ACH).

Duct Type	Flex Duct				Smooth Duct			
Fan Rating, cfm @ 0.25 in. w.c.	50	80	100	125	50	80	100	125
Diam (in)	Maximum length (ft)							
3	X	X	X	X	5	X	X	X
4	70	3	X	X	105	35	5	X
5	NL	70	35	20	NL	135	85	55
6	NL	NL	125	95	NL	NL	NL	145
7+	NL	NL	NL	NL	NL	NL	NL	NL

X = not allowed NL = no limit

Installing Local Exhaust Fans

Installers are responsible for ensuring that local exhaust fans actually deliver at least the minimum required ventilation rate. Most installers can simply follow the fan manufacturer's installation instructions. If instructions are not available or incomplete, they can use the prescriptive duct sizing table shown to the left. Or after installation is complete, they can physically measure delivered airflow using a flow hood, flow grid or other airflow measuring device.

Efficacy and Sound Levels for Local Exhaust Fans

The Home Ventilating Institute rates and the Energy Star program labels fans for airflow in cfm, and noise level in sones. Standards require that whole-building fans and continuously operated local exhaust fans have a maximum sone rating of 1.0. Intermittently operated local exhaust fans must have a maximum sone rating of 3.0. However, only fans designed to be surface-mounted in the living space, in a ceiling or wall, can be tested and rated for sones.

1. ASHRAE Standard 62.2-2010 CA, §8.2
2. 2013 Building Energy Efficiency Standards Subchapter 9, §150.2(a)1.C.
3. 2013 Residential Compliance Manual, 4.6.1, pg.4-57
4. Title 24, Part 11, § 4.505, pg. 29-30

Whole-building Ventilation Systems

Until recently, residential buildings received outdoor air through operable windows and infiltration – air leaking through cracks and holes in the building. However, leaky homes are difficult to heat and cool. Mechanical ventilation is now required in all new homes, and homes undergoing additions of over 1,000 ft^2, for the following reasons:

- New homes are tighter, have fewer leaks and less infiltration.
- Occupants leave windows closed, for reasons including outdoor noise, air pollution, allergies, asthma, security, and privacy.
- Tighter homes result in greater concentrations of indoor air pollutants, including volatile organic compounds (VOCs).[5]

Types of Whole-building Ventilation Systems

1. **Exhaust systems** remove indoor air, which is replaced by air entering the home through holes and leaks. For example, a fan operates continuously on low speed for whole-building ventilation, and boosts to high speed for local exhaust.
2. **Supply systems** use a fan to pull outdoor air from a clean location and deliver it to the home. For example, a fan pulls outdoor air through an air filter, and ducts it to bedrooms and living areas.
3. **Balanced systems** use two fans that exhaust and supply the same amount of air at the same time. For example, a heat recovery ventilator (HRV) exhausts air from each bathroom and delivers filtered air to bedrooms.

System Pros & Cons

- **Exhaust Pros**: The easiest, most affordable and energy efficient system to install and operate.
  Exhaust Cons: Entering air can come from the attic, crawlspace, garage or other polluted area; cannot be filtered.
- **Supply Pros:** Enables outdoor air to be filtered and delivered directly to living areas. Creates positive pressure in the house.
  Supply Cons: Filters must be accessible for maintenance. Ductwork increases installation costs.
- **Balanced Pros:** Enables use of a heat exchanger to transfer sensible heat between exhaust and supply air, to temper outdoor air before delivery.
  Balanced Cons: Two fans, a heat exchanger and additional ducts increase installation and operating costs, and reduce efficiency.

Minimum Requirements for Whole-building Ventilation Systems

The energy code provides two methods for sizing whole-building ventilation fans: **Fan Ventilation Rate** & **Total Ventilation Rate.** These methods determine the minimum continuous airflow rate. If a whole-building ventilation system operates intermittently, instead of continuously, the fan must be up-sized according to its fractional on-time and reduced ventilation effectiveness.[6]

Which Method?

The **Fan Ventilation Rate method** assumes a significant infiltration rate, and is therefore more appropriate for homes in which no special attempt is made to tighten the building. In tighter homes, this method could result in under-ventilation.

The **Total Ventilation Rate method** accounts for actual, measured building tightness and in tighter homes, increases the fan size to account for reduced infiltration. This method is more appropriate for zero-net-energy or other advanced homes that are designed to be tight, and whose tightness will be measured.

The **Total Ventilation Rate Method** calculates minimum fan flow using both equations below, where the infiltration value is estimated from the results of a blower door test.[7]

Total cfm = 0.03 (floor area, ft^2) + 7.5 (no. of bedrooms +1)

Fan cfm = Total cfm – Infiltration cfm

The **Fan Ventilation Rate Method** determines minimum fan flow based on the following equation or table below:

Fan cfm = 0.01 (floor area, ft^2) + 7.5 (no. of bedrooms + 1)

Ventilation Air Requirements, cfm					
Floor Area (ft^2)	Bedrooms				
	0-1	2-3	4-5	6-7	> 7
< 1500	30	45	60	75	90
1501-3000	45	60	75	90	105
3001-4500	60	75	90	105	120
4501-6000	75	90	105	120	135
6001-7500	90	105	120	135	150
> 7500	105	120	135	150	165

HERS Verification of Whole-building Ventilation Airflow

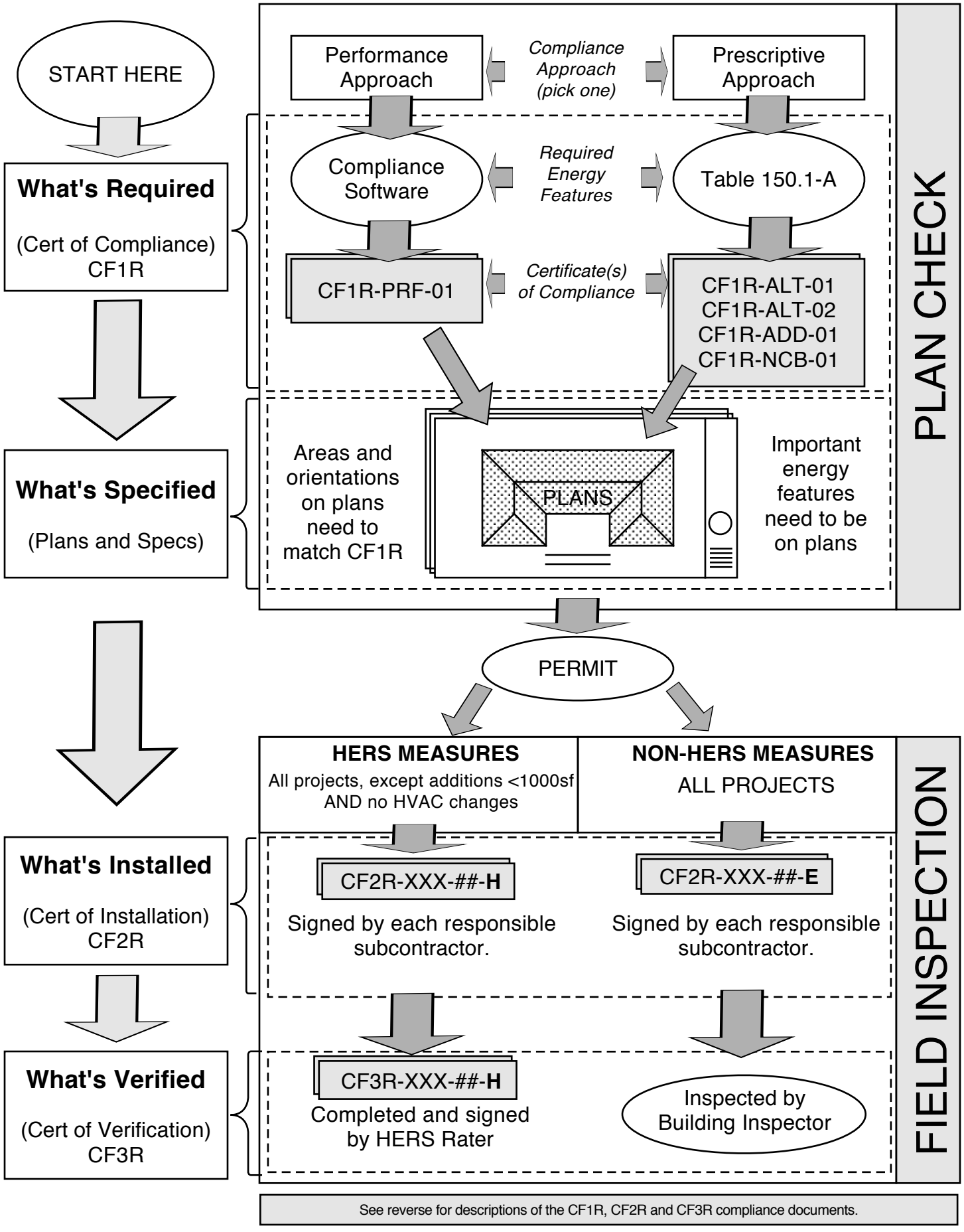
The Standards require HERS verification that whole-building ventilation rates comply with minimum requirements. Builders should consult HERS raters early in the process to ensure that the ventilation system is installed in such a way that airflow can be measured.

Building inspectors will look for the following:

- Energy Star labelled exhaust fans in bathrooms and kitchens, properly sized, ducted and controlled.
- Certificates of Installation from contractor (CF2R-MECH-27-H) documenting the type, make, model, required or rated cfm.
- Certificates of Verification from the HERS rater (CF3R-MECH-27-H) of whole building ventilation system airflow.

5. http://www.epa.gov/iaq/voc.html
6. Consult an energy consultant or HERS rater
7. ASHRAE Standard 62.2-2010 CA, § 4.1.2

THE COMPLIANCE PROCESS FOR RESDENTIAL NEW CONSTRUCTION AND ADDITIONS



See reverse for descriptions of the CF1R, CF2R and CF3R compliance documents.

Compliance Documents

CF1R – Certificates of Compliance

- **CF1R-ALT-01**: Used to demonstrate compliance for non-HVAC alterations (roof, windows, walls, etc.)
- **CF1R-ALT-02:** Used to demonstrate compliance for HVAC alterations. (change-outs, cut ins, re-ducts, etc.)
- **CF1R-ADD-01-E:** Used when the *prescriptive* approach is used to demonstrate compliance for additions less than or equal to 1000 square feet. See example in Appendix.
- **CF1R-NCB-01-E:** Used when the *prescriptive* approach is used to demonstrate compliance for newly constructed homes and additions over 1000 square feet.
- **CF1R-PRF-01-E**: Used when the *performance* approach is used to demonstrate compliance for any kind of project.

CF-2R – Certificates of Installation – Non-HERS Measures (-E)

- CF2R-ENV-01-E: fenestration (windows, skylights, etc.)
- CF2R-ENV-02-E: air sealing features (weather stripping, caulking, backdraft dampers, etc.)
- CF2R-ENV-03-E: insulation
- CF2R-ENV-04-E: roofing products
- CF2R-LTG-01-E: lighting features
- CF2R-MCH-01-E: mechanical systems (HVAC)
- CF2R-MCH-02-E: whole house fan
- CF2R-MCH-04-E: evaporative coolers
- CF2R-PLB-01-E: Multi-family central hot water distribution systems
- CF2R-PLB-02-E: Single-family central hot water distribution systems
- CF2R-PLB-03-E: Pool and spa heating systems

CF-2R – Certificates of Installation – HERS Measures (-H)

- CF2R-ENV-20-H: Envelope air leakage (blower door test)
- CF2R-ENV-21-H: QII Framing Stage (batt, loose fill, etc.)
- CF2R-ENV-22-H: QII Ceiling Air Barrier
- CF2R-ENV-23-H: QII Insulation Stage
- CF2R-ENV-24-H: QII Framing Stage (SIP & ICF)
- CF2R-MCH-20-H: sealed ducts*
- CF2R-MCH-21-H: Supply duct location verification
- CF2R-MCH-22-H: HVAC system fan efficacy (fan watt draw)*
- CF2R-MCH-23-H: HVAC system fan airflow*
- CF2R-MCH-24-H: Blower door, when infiltration used to meet whole house ventilation
- CF2R-MCH-25-H: HVAC system refrigerant charge*
- CF2R-MCH-26-H: Rated system verification (High SEER/EER)
- CF2R-MCH-27-H: ventilation to the ASHRAE 62.2 standard
- CF2R-MCH-28-H: Return Duct sizing table verification (alternative to airflow/Fan watt draw test)
- CF2R-MCH-29-H: Supply duct surface are and buried ducts verification
- CF2R-PLB-21-H: Multi-family central hot water distribution systems
- CF2R-PLB-21-H: Single-family central hot water distribution systems

For each CF2R-XXX-##-H there is a corresponding CF3R-XXX-##-H, Certificate of Verification

The HERS registry will make sure the correct HERS documents (CF2R and CF3R) get used and completed.

What to Inspect on an NRCC-PRF-01 Checklist

Note: The NRCC-PRF-01 is constantly being revised to be more useful. Check with BayREN for the most recent version of this material. Also, the NRCC used in this example is from CBECC Nonres. NRCC forms generated by Energy Pro will be slightly different.

HIGH Priority

☐ Document Header: Compliance Scope – this is where it would show if two or three building systems were modeled.

CERTIFICATE OF COMPLIANCE - NONRESIDENTIAL PERFORMANCE COMPLIANCE METHOD		**NRCC-PRF-01-E**
Project Name: 020012-OffSml-SZVAV	**Calculation Date/Time:**	Page 1 of 6
Compliance Scope: New Complete Building including Envelope, Lighting and HVAC	**Input File Name:**	

HIGH Priority

☐ Section A. General Information
- ☐ Building Front orientation
- ☐ Number of stories
- ☐ Total conditioned floor area
- ☐ Number of air systems
- ☐ Wall areas – should seem reasonable
- ☐ Glazing areas and glazing ratios – glazing areas are very important to compliance

A. GENERAL INFORMATION					
01	Project Address	- specify -	21	Compliance Software	CBECC-Com 2013-3 (653)
02	City	- specify -	22	Compliance Manager Version	BEMCmpMgr 2013-3 (653)
03	Zip code	95814	23	Rule Set Filename	CA 2013 Nonresidential, Vers. 2.0 (CEC 2013 NonRes.bin)
04	Climate Zone	ClimateZone12	24	Building Type	Nonresidential
05	Building Front Orientation	0	25	Construction Type	
06	Number of Above Grade Stories	1	26	North Wall Area (ft2)	909
07	Number of Below Grade Stories	0	27	East Wall Area (FT2)	606
08	Number of Dwelling Units	0	28	South Wall Area (ft2)	909
09	Total Conditioned Floor Area (ft2)	5,502	29	West Wall Area (ft2)	606
10	Total Unconditioned Floor Area (ft2)		30	Total Exterior Wall Area (ft2)	3,030
11	Addition Conditioned Floor Area (ft2)		31	North Glazing Area (ft2) / Glazing Ratio	180 / 20%
12	Addition Unconditioned Floor Area(ft2)		32	East Glazing Area (ft2) / Glazing Ratio	120 / 20%
13	Number of Thermal Zones	2	33	South Glazing Area (ft2) / Glazing Ratio	222 / 24%
14	Number of Thermal Zones (conditioned)	1	34	West Glazing Area (ft2) / Glazing Ratio	120 / 20%
15	Number of Air Systems	1	35	Total Glazing Area (ft2) /Glazing Ratio	642 / 21%
16	Number of Zonal Systems	0	36	Roof Area (ft2)	6,445
17	Number of Terminal Units	1	37	Skylight Area (ft2) / Skylight-Roof-Ratio	0 / 0%
18			38		
19			39		
20			40		

HIGH Priority

- ☐ Section B. Compliance Results
  - ☐ Building Complies
  - ☐ Total Percent Better than Standard – low numbers = less margin for error.

B. COMPLIANCE RESULTS				
01	BUILDING COMPLIES			
02	Special Features are Required -TBD			
03	HERS Verification is Required - TBD			
ANNUAL TDV ENERGY USE SUMMARY (kBtu/ft2/yr)				
	04	05	06	07
Energy Component	Standard Design	Proposed Design	Compliance Margin	Percent Better than Standard*
Space Heating	9.6	22.4	-12.8	-133.3%
Space Cooling	69.7	61.7	8.0	11.5%
Indoor Fans	85.8	22.3	63.5	74.0%
Heat Rejection	--	--	--	--
Pumps & Misc.	--	--	--	--
Domestic Hot Water	5.1	5.1	--	0.0%
Lighting	35.8	35.2	0.6	1.7%
COMPLIANCE TOTAL	**206.0**	**146.7**	**59.3**	**28.8%**
Receptacle	109.8	109.8		0.0%
Process	--	--		--
Process Lighting	--	--		--
TOTAL	**315.8**	**256.5**		**18.8%**

HIGH Priority

- ☐ Section C. Occupancy Summary Information
  - ☐ Floor area by occupancy type
  - ☐ Installed lighting power
  - ☐ Total allowed lighting power

C. OCCUPANCY SUMMARY INFORMATION -							
01	02	03	04	05	06	07	08
				Allowed (Baseline) Lighting Power			
					Additional (Custom) Allowances		
Occupancy Type	Floor Area	Installed Lighting Power	Lighting Control Credits	General Lighting Power Allowance	Area Category	Tailored Method	Total Allowed Lighting Power
	(ft2)	(Watts)	(Watts)	(Watts)	(Watts)	(Watts)	(Watts)
Office (Greater than 250 square feet in floor area)	5,502	4,127		4,127			4,127

MED Priority

- ☐ Section D. Envelope Summary Information
  - ☐ U-factors by surface type (areas will be detailed on an NRCC-ENV-01)

D. ENVELOPE SUMMARY INFORMATION							
01	02	03	04	05	06	07	08
				Assembly Layers			
Surface Name	Surface Type	U-Factor / F-Factor / C-Factor		Framing Type	Framing Spacing	R-value	Certified Cool Roof
Base_CZ12-NonresMetalFrameWallU062	ExteriorWall	U-0.06	Stucco - 7/8 in. Compliance Insulation R13.99 Air - Metal Wall Framing - 16 or 24 in. OC Gypsum Board - 1/2 in.			R-0.18 R-13.99 R-0.65 R-0.45	
Base_CZ12-SlabOnOrBelowGradeF073	UndergroundFloor	F-0.73	Concrete - 140 lb/ft3 - 6 in.			R-0.44	
Base_CZ12-SteepNonresWoodFramingAndOtherRoofU039	Roof	U-0.04	Metal Standing Seam - 1/16 in. Compliance Insulation R24.86			R-0 R-24.86	
Base_CZ12-NonresOtherFloorU071	ExteriorFloor	U-0.07	Compliance Insulation R9.83 Plywood - 5/8 in. Carpet - 3/4 in.			R-9.83 R-0.78 R-2.38	

HIGH Priority

☐ Section E. Fenestration Summary Information
  ☐ U-factor and SHGC by name (areas will be detailed on an NRCC-ENV-01)

E. FENESTRATION SUMMARY INFORMATION							
01	02	03	04	05	06	07	08
Name	Fenestration Type	Certification Method	Assembly Method	Frame Type	U-value	SHGC	VT
Fixed Window	- n/a -	NFRCRated	Manufactured	- n/a -	0.32	0.23	0.47
Store Front	- n/a -	NFRCRated	Manufactured	- n/a -	0.36	0.25	0.42
Site Built Opp	- n/a -	NFRCRated	Manufactured	- n/a -	0.39	0.27	0.45

HIGH Priority

☐ Section F. Mechanical System Summary Information (systems will be detailed on NRCC-MCH-##-E documents)
  ☐ Number of systems
  ☐ Cooling efficiencies
  ☐ Heating efficiencies
  ☐ Rated Outputs and supplemental heat info if heat pump

F. MECHANICAL SYSTEM SUMMARY INFORMATION													
01	02	03	04				05						
			Cooling				Heating						
Equipment Name	Equipment Type	Qty	Type	SEER	EER	Rated Output kBtuh	Type	AFUE	HSPF	Thermal Eff.	Rated Output kBtuh	Supplemental Heat Source	Supplemental Rated Output kBtuh
CoreZnPSZ AirSys	SZVAVAC	1	DirectExpansion		10.8	149	Furnace	0.78			108.4		

HIGH Priority

☐ Section G. Mechanical System Economizer and Fan Summary Information (systems will be detailed on NRCC-MCH-##-E documents)
  ☐ All information in this section is important to compliance.

G. MECHANICAL SYSTEM ECONOMIZER AND FAN SUMMARY INFORMATION										
01	02	03	04				05			
		Outside Air	Supply Fan				Return Fan			
Equipment Name	EconomizerType	CFM	CFM	HP	BHP	Control	CFM	HP	BHP	Control
CoreZnPSZ AirSys	NoEconomizer	825	4951.9	5	3.90184	VariableSpeedDrive				

☐ Section H. Chiller Summary Information (systems will be detailed on NRCC-MCH-##-E documents)
  ☐ Usually only on very large projects. Require design review and commissioning documents to be filled out (NRCC-CXR-01-E)

☐ Section I. Cooling Tower Summary Information (systems will be detailed on NRCC-MCH-##-E documents)
  ☐ Usually only on very large projects. Require design review and commissioning documents to be filled out (NRCC-CXR-01-E)

HIGH Priority

☐ Section J. Boiler Summary Information (systems will be detailed on NRCC-MCH-##-E documents)
  ☐ If boiler specified, all information in this section is important.

HIGH Priority

☐ Section K. Central Mechanical System Pump Summary Information (systems will be detailed on NRCC-MCH-##-E documents)
  ☐ If central mechanical system pumps specified, all information in this section is important.

MED Priority

- ☐ Section L. Terminal Unit Summary Information (systems will be detailed on NRCC-MCH-##-E documents)
  - ☐ Should match mechanical plans

L. TERMINAL UNIT SUMMARY INFORMATION

01	02	03	04	05	06	07	08	09	10	11	12	13
Terminal Unit Name	Terminal Unit Count	System Count	HVAC Zone Count	Primary HVAC System	Terminal Unit Type	Terminal Heat Type	Heating Capacity kBtuh	Primary Air CFM	Minimum Primary Air Ratio	Secondary Air CFM	Max Pri. Air in Heating CFM	Terminal Unit Fan BHP
CoreZn TU	1	1		CoreZnPSZ AirSys	VAVNoReheatBox		NaN	4,952	0.50		NaN	

- ☐ Section K. Zonal System Summary Information (systems will be detailed on NRCC-MCH-##-E documents)
  - ☐ If Zonal System information specified, all information in this section should match plans.

- ☐ Section M-1. DHW Summary Information (systems will be detailed on NRCC-PLB-##-E documents)
  - ☐ All information in this section is important.

HIGH Priority

M-1. DHW SUMMARY INFORMATION: FLUID SYSTEMS

01	02	03	04	05	06	07	08
DHW Heater Name	Fuel Source	Type	Distribution	Rated Input Btuh	Effiency EF or RE	Standby loss Btuh	Tank External R-value
WaterHeater1	NaturalGas	Storage	Nonrecirculating	6655	0.78		

See Detailed Building Report for additional information on the domestic hot water heater system information data entered in the model.

HIGH Priority

- ☐ Section 2.DHW Summary Information Recirculation Systems(systems will be detailed on NRCC-MCH-##-E documents)
  - ☐ If DHW Recirculation System information is specified, all information in this section should match plans.

HIGH Priority

- ☐ Declaration Statements

☐ Make sure these are completed and signed by **ALL** responsible parties. VERY IMPORTANT

DOCUMENTATION AUTHOR'S DECLARATION STATEMENT	
1. I certify that this Certificate of Compliance documentation is accurate and complete.	
Documentation Author Name: - specify -	Documentation Author Signature:
Company: - specify -	Signature Date:
Address: - specify -	CEA Identification (If applicable):
City/State/Zip:	Phone: - specify -
RESPONSIBLE PERSON'S DECLARATION STATEMENT	
I certify the following under penalty of perjury, under the laws of the State of California: 1. I hereby affirm that I am eligible under the provisions of Division 3 of the Business and Professions Code to sign this document as the person responsible for its preparation; and that I am licensed in the State of California as a civil engineer, mechanical engineer, electrical engineer, or I am a licensed architect. 2. I affirm that I am eligible under the provisions of Division 3 of the Business and Professions Code by section 5537.2 or 6737.3 to sign this document as the person responsible for its preparation; and that I am a licensed contractor performing this work. 3. I affirm that I am eligible under Division 3 of the Business and Professions Code to sign this document because it pertains to a structure or type of work described as exempt pursuant to Business and Professions Code Sections 5537, 5538 and 6737.1.	
Building Owner's Name: - specify -	Building Owner's Signature:
Address: - specify -	Date Signed:
City/State/Zip:	Phone: - specify -
Responsible Designer Name: - specify -	ResponsibleDesigner Signature:
Company: - specify -	Date Signed:
Address: - specify -	License:
City/State/Zip:	Phone: - specify -
Responsible Lighting Designer Name: - specify -	Responsible Lighting Designer Signature:
Company: - specify -	Date Signed:
Address: - specify -	License:
City/State/Zip:	Phone: - specify -
Responsible Mechanical Designer Name: - specify -	Responsible Mechanical Designer Signature
Company: - specify -	Date Signed:
Address: - specify -	License:
City/State/Zip:	Phone: - specify -

What to Inspect on a CF1R

Project Name: _____ Date: _____

- General Information Section

HIGH Priority

  - ☐ Climate Zone
  - ☐ Project Scope (new, addition, etc.)
  - ☐ Total Conditioned Floor area
  - ☐ Front Orientation (degrees or "Cardinal" if master plan)
  - ☐ Number of Dwelling Units
  - ☐ Number of Stories
  - ☐ Glazing percentage (Anything over 20% is more than standard and penalized)

- Compliance Results Section

HIGH Priority

  - ☐ "Building Complies" Statement
  - ☐ "Building Incorporates HERS Features" Statement
  - ☐ "Building Incorporates Special Features" Statement
  - ☐ TIP: Compliance Margin and Percent
    - <1% = no margin for error
    - >15% = possible Energy Star or reach code

- Required Special Features Section

MED Priority

  - ☐ Worth tracking, if listed

- Project HERS Features
  - ☐ Quick Check (HERS features listed in various sections)

- Building Features Information Section
  - ☐ Quick Check (No need to spend much time.)

- Zone Information Section
  - ☐ Quick Check (note: dwelling units are not *required* to be divided into zones unless served by equipment of different *types* or *efficiencies*)

- Opaque Surfaces Section

MED Priority

  - Lists all unique walls, floors, ceiling, etc.
  - Cathedral ceilings, windows, doors and slab floors are detailed in later sections.
  - Column 03 "Construction" references a later section that details each surface type.
    - ☐ Quick Check azimuth/orientations, areas and tilts.
    - ☐ All sides of house should be listed (unless attached to conditioned space).
    - ☐ Roof area should make sense relative to floor area.
    - ☐ Wall areas should be reasonable (perimeter of house x average ceiling height).

- Attic Section

  - ☐ If **radiant barrier** is specified, installation is important and should be tracked through process (plan check and field inspection).
  - ☐ If **cool roof** is specified, reflectance and emittance are important and should be tracked through process (plan check and field inspection).

- Windows Section - VERY IMPORTANT

  - ☐ Check Areas and Orientations against plans.
  - ☐ Check U-Factor and SHGC against NFRC labels in field.
  - ☐ **Tip: If you are limited on time, check the window area for the orientation with the most glass area.**

- Overhangs and Side Fins Section

  - ☐ If modeled, they have a significant impact on compliance.
  - ☐ Verify against plans.
  - ☐ Verify in field.
    - ☐ **Depth is the most important dimension**

- Opaque Surface Constructions Section

  - ☐ Match construction name in column 01 to column 03 of the previously discussed "Opaque Surfaces" section.
  - ☐ Look for unusual assemblies (24 o.c., etc).
  - ☐ Note cavity **and** sheathing (continuous) R-values.
  - ☐ No U-factors shown! (hopefully will be added to later versions)
    - ☐ Use Appendix JA4, if needed.

- Slab Floors Section
  - ☐ Quick Check

- Building Envelope HERS Verification Section

  - ☐ If any are listed you know that a special inspector will be in charge of that feature (Will need CF3Rs.)
    - Quality Insulation Installation (QII)
    - Building Envelope Air Leakage
    - "ACH@50 Pa" is the target for the blower door test, if required.

- Water Heating Systems and Water Heaters Sections

  - ☐ Very important, especially in mild climates (see WH compliance margin in Compliance Results Section).
  - ☐ Verify all information in field: type, number, volume, efficiencies

- Water Heating – HERS Verification Section

  - ☐ If any HERS measures are listed you know that a special inspector will be in charge of checking those features (Will need CF3Rs.):
    - Pipe insulation,
    - Parallel piping/compact distribution/point-of-use
    - Recirculation with manual control/Recirculation with sensor control

- **HVAC Systems, Heating Systems and Cooling Systems Sections** - Very Important

  - ☐ Confirm duct locations on plans.
  - ☐ Verify all information at field inspection:
    - ☐ system types
    - ☐ efficiencies

- **HVAC Cooling HERS Verification Section**

  - ☐ Verification of Airflow by HERS Rater will be required on all ducted systems with A/C. (Will need CF3Rs.)
  - ☐ If so, Cooling System will be checked by Rater

- **HVAC Distribution and Distribution HERS Sections**

  - ☐ Verify duct location on plans
  - ☐ Duct leakage testing required on all ducted systems >10 feet.
  - ☐ If so, distribution system will be checked by Rater (Will need CF3Rs.)

- **HVAC Fan Systems and Fan Systems HERS Sections**

  - ☐ Verification of Fan Watt Draw by HERS Rater will be required on all ducted systems with A/C.
  - ☐ If so, Cooling System will be checked by Rater (Will need CF3Rs.)

- **Indoor Air Quality Fans Section**

  - ☐ IAQ airflow almost always checked by Rater. (Will need CF3Rs.)
  - ☐ Spot ventilation (kitchen hood, bathroom fans, laundry rooms, etc.) **NOT** checked by Rater.

- **Cooling Ventilation -** Special cooling credits

  - ☐ If listed, worth tracking and field verifying.
  - ☐ Whole house fans
  - ☐ Night ventilation

- **Declaration Statements -** Provide accountability in the event of future problems.

  - ☐ The single MOST IMPORTANT item to check is that the documents are signed and registered.
  - ☐ Digital Signatures are Legal

Notes:

What to Inspect on a CF2R-ENV-01, 02, 03

These are currently hand-filled forms. They are to be completed and signed by the installer for all new construction projects and most additions. Collecting completed/signed copies of these compliance documents helps ensure that the installer is being accountable for the energy features that they installed, however, it does not ensure that the correct features actually got installed.

The following items highlight the more important features spelled out on the CF2R-ENV forms. There are many more items on the forms besides those highlighted below.

CF2R-ENV-01 *Fenestration* Certificate of Installation

Section B. Fenestration Installation.

- ☐ Item 01 - For new construction, installed window U-factor and SHGC values should be equal to or less than listed on the CF1R.
- ☐ Item 02 - For existing buildings the U-factor and SHGC values should be the same or better than the required Energy Commission prescriptive requirements.
- ☐ Item 03 - Temporary labels should not be removed until verified by the building inspector.
- ☐ Item 04 - The fenestration product manufacturer's installation specifications shall be followed when installing these products. The space between the fenestration product and rough opening shall be completely filled with insulation. If batt insulation is used, it is cut to size and placed properly around the fenestration product.

CF2R-ENV-02 *Envelope Air Sealing* Certificate of Installation

Section B. RAISED FLOOR AIR BARRIER

- ☐ Item 01 - All gaps in the raised floor are sealed.
- ☐ Item 02 - All chases sealed at floor level using a hard cover and the hard cover is sealed.
- ☐ Item 03 - All plumbing and electrical wires that penetrate the floor are sealed.
- ☐ Item 04 - Subfloor sheathing is glued or sealed at all exterior panel edges to create a continuous airtight subfloor.

Section C. WALL/KNEE WALL AIR BARRIER

- ☐ Item 02 - Exterior wall air barrier is sealed at the top plate and bottom plate in each stud bay.
- ☐ Item 04 - All openings in the top and bottom plate, including all interior and exterior walls, to unconditioned space are sealed.
- ☐ Item 05 - Exterior bottom plates (all stories) are sealed to the floor, using the appropriate method under the entire exterior bottom plate of the home.
- ☐ Item 06 - All gaps around windows and doors are sealed. The sealant used follows window manufacturer specifications.
- ☐ Item 07 - Rim joist gaps/openings are fully sealed.
- ☐ Item 08 - Fan exhaust ducts that run between conditioned floors to exterior walls include a damper at the exterior wall.

Section D. CEILING/ATTIC AIR BARRIER

- ☐ Item 03 - All eave vents are covered with a rigid ventilation baffle that maintains the net free ventilation area.
- ☐ Item 04 - All dropped ceilings/soffits are covered with hard covers and sealed to framing.
- ☐ Item 05 - All chases are covered with hard covers and sealed to framing.
- ☐ Item 06 - Where HVAC ducts travel down a chase, the chase is sealed at the ceiling level.
- ☐ Item 09 - Double walls that open to an attic are enclosed with an air barrier and cover that has an airtight seal to the framing.

Section G. CANTILEVERED FLOOR AIR BARRIER

- ☐ Item 01 - Airtight blocking is installed between joists where the wall rim joist would have been located in the absence of a cantilever.

CF2R-ENV-03 *Insulation* Certificate of Installation

Section A. ROOF/CEILING INSULATION

☐ It is worth confirming the manufacturer, brand, type and R-value of the insulation.

Section B. WALL INSULATION

☐ It is worth confirming the manufacturer, brand, type and R-value of the insulation.

Section D. RAISED FLOOR INSULATION

☐ It is worth confirming the manufacturer, brand, type and R-value of the insulation.

Section G. MINIMUM MANDATORY MEASURES

☐ Item 06 - All 2x4 wood-frame walls have a minimum R-13 insulation or equivalent U-factor.
☐ Item 07 - All 2x6 wood-frame walls have a minimum R-19 insulation or equivalent U-factor.
☐ Item 08 - All wood-framed ceilings have a minimum R-30 insulation or equivalent U-factor.

Section H. INSTALLED INSULATION

☐ Item 01 - Installed insulation R-values are the same or greater than listed on the CF1R.
☐ Item 02 - No gaps or voids between the insulation and framing.
☐ Item 03 - No gaps between the sides or ends of batt insulation.
☐ Item 04 - Loose-fill insulation must be installed to the minimum installed weight per square foot (density) of the manufacturer's cut sheet for the proposed R-value.
☐ Item 05 - Batt insulation is not compressed (no stuffing of the insulation into the cavity) and is installed to its full thickness.
☐ Item 06 - Insulation is cut around obstructions such as electrical boxes.
☐ Item 07 - Batt insulation is delaminated around all plumbing and electrical lines in ceilings, walls, and floors.
☐ Item 08 - Band joists are insulated to the same R-value as the wall.
☐ Item 09 - In all narrow cavities the insulation shall be cut to fit or filled with expanding foam.
☐ Item 10 - Insulation was installed per manufacturer instructions.

Section I. WALL INSULATION

☐ Item 02 - Install wall insulation before installing tubs, showers, and fireplaces.
☐ Item 06 - Corner channels, wall intersections, and double sided shear walls are insulated to the required R-value before enclosing the wall.

Section J. CEILING/ROOF INSULATION

☐ Item 02 - Insulation is in direct contact with ceiling, so there are no gaps between the ceiling and the insulation.

Section K. RAISED FLOOR INSULATION

☐ Item 01 - Insulation is in full contact with subfloor.
☐ Item 02 - Insulation hangers are spaced at 18 inches or less; insulation hangers must not compress insulation.