1800 Larimer Street
Denver, Colorado 80202

1-800-895-4999
xcelenergy.com

Energy Code Support Pilot – Evaluation Summary
October 15, 2013

As part of the 2012 Demand-Side Management (DSM) Settlement Agreement, the Southwest Energy Efficiency Project (SWEEP) proposed that Public Service Company of Colorado ("Public Service" or the "Company") conduct a Building Energy Code Support Pilot to determine if targeted training and support to municipalities and the local building community could improve code compliance or encourage adoption of more stringent energy codes. A description of the pilot effort and a summary of the results are described herein.

Background

The Company began developing the pilot in 2012 with the objective of determining if energy code support for jurisdictions (cities and counties) and their local building communities could result in additional energy savings through adoption of more stringent codes and increased code compliance. Municipalities were recruited from the Denver metropolitan area and six agreed to participate in the pilot. Colorado Code Consulting (CCC) LLC was hired to implement the pilot and work with each participating jurisdiction to determine a baseline of code knowledge, enforcement, adoption, and procedures, and to design custom trainings that would either improve code enforcement or help municipalities move to a more stringent code.

All six jurisdictions received code training and support, based on their level of need. Trainings were held for contractors and designers in all six jurisdictions. Building inspectors were trained in five jurisdictions; and plan reviewers were trained in four jurisdictions. These activities led to four jurisdictions adopting new code policies or procedures. Only one of the six participating municipalities was interested in moving to more stringent energy code adoption, but changes in building official staffing prevented this effort from moving forward within the timeframe of this pilot. Therefore, the Company was unable to determine if training was an effective tool to encourage migration to more stringent energy codes.

Furthermore, the Company was unable to effectively evaluate commercial code compliance through the pilot based partly on the long building cycle for commercial buildings compared to the relatively short duration of the pilot. Fortunately the Colorado Energy Office (CEO) was performing a review of commercial code compliance simultaneously to the Company's pilot. This study showed compliance rates were very high. As the CEO's methodology was similar to the Company's that indicated high compliance for residential buildings, it was determined that extending the pilot further to complete reviews of commercial buildings would not be a prudent use of funds.

Evaluation Overview

The Heschong-Mahone Group (HMG) was hired to perform an evaluation of the pilot. They used the data collected by CCC to determine the baseline level of code compliance in each municipality and then compared that to the compliance levels measured post-training to determine any changes from the baseline.

Evaluation could not be completed for three of the six participating jurisdictions, for several reasons, which included:

- insufficient access to collect the data necessary for baseline calculation
- limited contact time to train the jurisdiction's plan reviewers and/or inspectors;
- other competing municipal priorities took precedence over engaging in the pilot activities; or
- staff turnover within the jurisdiction during the timeframe of pilot implementation and evaluation.

Evaluation Results

The baseline code compliance rate was determined to be very high, ranging from 87% to 93% across the three municipalities where it could be measured. This high compliance rate suggests there are limited additional potential savings achievable from a stand-alone code compliance program.

Nonetheless, there was an overall increase in compliance post-training, where compliance rates ranged from 93% to 95%. Two of the three municipalities showed an increase in compliance rates, while one showed a decrease. Due to the small sample sizes, the statistical confidence factor is relatively low which could explain why one municipality saw its compliance rates appear to decrease.

Participating Jurisdiction	Pre-Training		Post-Training	
	Number of Sites Baselined*	Weighted Overall Compliance Rate	Number of Sites Evaluated*	Weighted Overall Compliance Rate
Jurisdiction A	13	90.5%	13	95.3%
Jurisdiction B	13	87.0%	9	92.8%
Jurisdiction C	6	96.3%	11	93.7%

*There is not a one-to-one correlation between the sites baselined and the sites evaluated. The sites consist of representative samples of the buildings available for review during the baseline collection and evaluation stages of the pilot.

Although none of the participating jurisdictions adopted new codes during the pilot, the Company did investigate the potential savings that could be generated from a program designed to accelerate the adoption of the next code level. The estimated potential savings of moving from the current code level in each jurisdiction to the IECC 2012 residential / commercial building code was calculated using publicly available data on new residential building starts, combined with information from the Company's Builders Call Line. The savings potential, though larger than the potential from a compliance program, was relatively small. Additionally, a

method to attribute potential savings to the Company's DSM program does not yet exist. Several states are grappling with this same issue. Without a clear mechanism to attribute savings it is imprudent to make the investment of time and personnel to pursue a program with limited savings potential. If a replicable program model is developed the Company may revisit the program concept.

Next Steps

The Company's Building Energy Code Support Pilot will be concluded in December 2013, as planned, and as documented within the 60-Day Notice that was filed to initiate the pilot, as little additional information is likely to be gained by working with participating jurisdictions further. The Company does not recommend developing a stand-alone building energy codes program at this time given the high compliance rates statewide, and the challenges in assigning attribution of energy savings. Instead, the Company will focus building energy code efforts on improving the training already provided through existing residential and business new construction DSM programs. Additionally, the Company is investigating updating the baseline for new construction DSM programs to reflect the actual measured code compliance, and not an assumed 100% compliance.

Lastly, CEO is working to determine code compliance levels of jurisdictions throughout the state. The Company intends to monitor these results to determine if there are any changes in code compliance rates over time. Should there be a large decrease in compliance; the Company will revisit offering a stand-alone Code compliance program. The Company will also collaborate with CEO to determine if there are synergies between the training efforts that each organization is offering.

The Building Energy Code Support Pilot Evaluation prepared by HMG is attached; and has been posted to our website, available at:
http://www.xcelenergy.com/About_Us/Rates_&_Regulations/Regulatory_Filings/CO_DSM.

1-800-481-4700
www.xcelenergy.com

Energy Code Training Pilot Evaluation Report

Date: July 23, 2013

Submitted to:

Xcel Energy
Public Service Company of Colorado

Submitted by:

Heschong Mahone Group, Inc. (a TRC Company)
11211 Gold Country Blvd. #103
Gold River, CA 95670
Phone: (916) 962-7001
Fax: (916) 962-0101
e-mail: CChappell@trcsolutions.com

TABLE OF CONTENTS

TABLE OF FIGURES

EXECUTIVE SUMMARY

Xcel Energy (Public Service Company of Colorado) initiated a Code Support Pilot in 2012, and hired Colorado Code Consulting (CCC), LLC to develop and implement personalized energy code training for six (6) jurisdictions that volunteered to participate in the pilot. Training plans were developed and customized by CCC and the participants, to meet the needs of each jurisdiction. Xcel Energy and CCC identified three distinct stages of code enforcement and compliance that could warrant training and education to lead to increased code compliance; 1) submittal process, 2) plan review and 3) field inspections.

The Heschong Mahone Group (HMG) was hired to conduct the evaluation of the pilot. The plan for this pilot evaluation was relatively straightforward: compare estimates of the compliance rates before and after Xcel Energy-funded trainings were administered to determine the effectiveness of the training.

Baseline data about the submittal process was collected by CCC, relying on interviews with building department officials in each jurisdiction and publicly available documents related to submittal requirements on their websites. Baseline assessments of the plan review and inspection processes were completed by CCC using the BECP compliance evaluation checklists for plan reviews and site inspections before training was complete.

The post-training data collection was conducted by HMG using the same data collection instruments that were used for the pre-training data collection. The evaluation data collection effort consisted of both plan review and field inspections for each jurisdiction.

The pre- and post-training data was used to assess the effectiveness of the training and estimate overall compliance rates.

1.1 Response to Study Questions

The evaluation intended to answer several questions in order for Xcel Energy to determine whether a broader program was warranted. Based on our analysis of the data available, we provide the following responses:

- *Will a tailored approach to code training and technical support help jurisdictions adopt new energy codes? Can we quantify additional energy savings?*
  - While this evaluation did not ultimately address this question directly, we believe that training and technical support to the jurisdictions does help them better understand the code requirements and therefore better able to assess the implications of increasing the code stringency by adopting a newer energy code.
  - The savings for this activity would be relatively easy to quantify directly from the differences between the two versions of the code, as we have done for this evaluation.
- *Will a tailored approach to code training and technical support help improve and accelerate code compliance? Can we quantify additional energy savings?*

- Yes, we conclude that the tailored training and technical support to the jurisdictions helped them better understand the code requirements and therefore were better able to enforce the code.
- We have provided a rough estimate of energy savings attributable to the training efforts.

- *Can the DOE Building Energy Codes Program (BECP) protocol be used cost-effectively to evaluate the Code Support pilot?*
  - There are two important elements of evaluating the Code Support pilot. The first entails evaluating changes in code compliance, for which the BECP protocol can appropriately be used, with the caveats discussed in this report. In order for the BECP protocol to be most effective, since it does not penalize projects for not having the documentation available, all necessary documentation must be available and reviewed consistently throughout the process. The compliance calculation relies of detailed and consistent compliance documentation, including HVAC load calculations and equipment sizing documentation.
  - The other element requires evaluating energy savings based on the compliance improvement; which the BECP protocol is ill-suited to do on its own. Additional research is needed to develop an appropriate weighting formula that would allow for compliance rates to directly inform energy savings estimates. However, it is not clear whether this would be more valuable than developing prototype energy models based on standard construction practices identified as part of a compliance assessment.
  - While we have not discussed the exact definition of cost-effective with Xcel, we think the approach followed for this evaluation was a reasonable use of the BECP protocol. The BECP protocol calls for a self-assessment of baseline compliance, which would certainly reduce the cost of data collection for evaluating a larger code support program. However, the self-reported baseline compliance data may not be consistent with the third party evaluation data, complicating the evaluation of the program impacts. Relying on self-assessments for evaluation would further reduce costs, but may raise questions about the objectivity and reliability of the data.
- *Can we attribute savings to this pilot?*
  - While quantification of the savings from the improvements in code compliance are possible, we do not believe that savings can be attributed to this pilot for reasons documented throughout the report. The explicit link between the improvements in compliance and the training provided is not possible based on the data collected. We reach this conclusion primarily because, as stated above, the training pilot actually needed to provide fundamental review and consistency training that is a pre-cursor to actual improved compliance and verification. Continued training of these and other jurisdictions will allow for improved compliance and proper documentation that will allow for better compliance verification. Additionally, the condensed timeframe of the pilot did not allow for sufficient time to evaluate projects that were constructed based on plans that had been reviewed after the plan reviewers received training. Furthermore, competing trainings provided by CCC under contracts with the State or

entities other than Xcel were not fully vetted during the evaluation, which would affect the attribution of savings.

- *What are the potential and achievable savings for the pilot jurisdictions?*
  - Although there may not be savings directly attributable to this pilot, we have estimated potential energy savings, based on the change in code compliance found in this pilot. The results are provided in Section 1.3.

1.2 Compliance Rates

The goal of this evaluation study was to determine whether the training provided to the jurisdictions made any difference in the compliance of specific measures, and whether compliance with the 2009 International Energy Conservation Code (IECC) improved overall. During the course of the data analysis, the evaluators concluded that without substantial information on compliance rates, and the compliance rate improvement, it would not be possible to conclusively determine the overall improved compliance rate nor estimate potential energy savings. The BECP Score + Store™ tool was used to develop an estimate of the overall compliance rate based on the limited data that we were able to collect during the study period. However, the evaluation is unable to answer several key questions related to HVAC load calculations and equipment sizing due to the lack of documentation associated with those requirements. The majority of the data collected is related to insulation R-values and glazing U-factors. Some of the projects did include ACCA Manual J (Manual J) documentation, which allows for a review of the HVAC load calculations, however that information was often unavailable at the project site. Particularly during the pre-training data collection, field inspections were rarely accompanied by Manual J documentation of the load calculation, precluding the ability to assess whether equipment installed on site matches the plans. This remained an issue during the post-training assessment, but additional effort was expended to acquire Manual J documentation for projects inspected in the field whenever possible.

Figure 1 shows the weighted overall compliance rate for each jurisdiction, pre- and post-training. The number of sites that provided the data for estimating the compliance rate is also included in the table. Both pre- and post-training compliance rates were found to be relatively high, ranging from 87.0% to 96.3%. The first two jurisdictions showed an improvement in compliance, while the third jurisdiction showed a decrease in compliance. We surmise that the negative change in compliance rate is likely indicative that the pre-training compliance rate was already very high (greater than 96%) based on a small sample size (six sites) where non-compliant measures were unable to be observed, therefore boosting the compliance rate as compared to the post-training sample.

Due to the small sample sizes, the statistical confidence of the compliance rates being reported is very low. These compliance rates are calculated based on measures that were observed at the time of the evaluation. Measures that were not available for observation were not considered in the calculation of the overall compliance rate, and therefore did not improve or penalize the compliance score.

Jurisdiction	Pre-Training		Post-Training	
	Number of Sites*	Weighted Overall Compliance Rate	Number of Sites*	Weighted Overall Compliance Rate
Jurisdiction A	13	90.5%	13	95.3%
Jurisdiction B	13	87.0%	9	92.8%
Jurisdiction C	6	96.3%	11	93.7%

Figure 1: Summary of Weighted Overall Compliance Rates pre- and post-training

*There is not a one-to-one correlation between the sites baselined and the sites evaluated. The sites consist of representative samples of the buildings available for review during the baseline collection and evaluation stages of the pilot.

1.3 Estimated Savings Associated With Change in Compliance Rates

The most accurate methodology to estimate energy savings would involve building a model using the weighted average input values from the pre-training survey and compare the energy use with a model of the same prototype building using the values from the post-training survey of projects. The savings between these two scenarios could then be scaled up to reflect the level of construction activity. However, the pilot study evaluation did not have the time or the resources to conduct such an in-depth calculation approach.

We used an alternative approach assuming the whole-building compliance rate to be a reasonable proxy for the percent of total energy savings being realized via energy code compliance. For purposes of this calculation, non-compliant measures were assumed to be compliant with the 2006 IECC instead of the 2009 IECC.

Values of energy savings associated with the IECC were obtained from the BECP Colorado Residential IECC report.[1] According to the report, residential buildings built to the 2009 IECC save 9.3 percent of energy costs compared to those built to the 2006 IECC. This equates to savings of approximately 394 kWh and 105 therms per house per year. The estimate of energy

[1] http://www.energycodes.gov/sites/default/files/documents/ColoradoResidentialCostEffectiveness.pdf

savings per single family house in the three jurisdictions assessed for this pilot are presented in Figure 2.

Jurisdiction	A	B	C
Compliance delta	4.8%	5.8%	-2.6%
Savings (kWh)	18.9	22.9	(10.3)
Savings (Therms)	5.0	6.1	(2.7)

Figure 2: Estimated Energy Savings per single family house per Jurisdiction

The results for Jurisdiction C exemplify the challenges of this pilot evaluation. Perhaps more important than the sample size of the pre- and post-training samples, is the focus of which measures were evaluated as part of that sample. The provision of construction drawings and documentation demonstrating energy code compliance is the first requirement on the BECP checklist and provides the basis of information to answer subsequent questions; yet the pre-training sample frequently lacked sufficient documentation or information to conclusively answer this question. However, because the BECP protocol does not penalize projects for having specific information unavailable, the absence of data from the pre-training sample appears to have artificially boosted the compliance rates for Jurisdiction C during that timeframe.

It is not obvious from our limited data whether the training that has been conducted to date with funding from Xcel Energy is resulting in additional energy savings.

1.4 Benefits of Trainings

While our quantitative evaluation results are statistically inconclusive as to whether energy code support and training result in direct energy saving, there are real and valuable benefits to a code training program. There is certainly a need for additional education and training on energy code requirements for both the building department staff and the building community, including designers, contractor and HERS raters; to provide them with the resources and the confidence to meet the code. Based on the results and feedback of the jurisdictions evaluated, we conclude that the training program provides increased consistency within and across the jurisdictions. The long term benefit is that the entire design community, including building department staff, will pay greater attention to building energy code requirements.

HMG compared pre and post training results, at both the plan review and field inspection level, to find indications of improved code compliance as a result of the training. We examined how procedures changed as a result of the training, which can produce long term code compliance improvement and energy savings that do not show up in this short term evaluation of compliance rates.

Currently there is not enough consistent data through design and construction to determine with any confidence that the equipment size is 1) based on the load calculations or 2) would result in reduced equipment sizing even if the load calculations were followed. Currently, the industry

uses standard rules of thumb for equipment sizing and oversizing safety factors. These practices are very slow to change. Understanding and enforcement of the code requirements by the building department staff is the first step in the long process of changing current practice to achieve better designed systems.

There is a need for on-going and sustained training opportunities with the plan review process. Training and education are needed to increase core knowledge of specific items, such as use of proper climate data and how to review Manual J. Increased understanding of code, ACCA Manuals J, S and D, and energy documents will improve the confidence, speed and efficiency of plan reviewers.

There is a general lack of field knowledge of energy code requirements. Field inspections tend to rely on the HERS rater for the energy code elements of the inspection, while some mandatory elements of the code are not checked or used by raters to calculate the HERS score. There is an opportunity to provide additional field training. Improved field knowledge will result in better understanding of energy compliance documentation and the approval process.

Our follow up conversations with trained building department staff suggests that better training of staff will increase confidence, allowing them to request additional information from builders. Once builders know that the building departments are requiring complete energy compliance submittals and they understand those requirements, they will submit complete and consistent documentation. These two inter-related efforts will produce better overall code compliance.

1.5 Recommendations for a Code Support Program

Based on our evaluation efforts, we have the following observations and recommendations for a continued and expanded code support program.

New Construction programs are justified on improvements over baselines, and changes to code impact this baseline. Advancements in codes can impact the ability of traditional utility incentive programs to encourage advanced design. However, tension can be reduced through integrated program activities involving both new construction and code support. With any adoption of more stringent codes, outreach efforts are needed to support implementation. By developing a new program theory and implementation approach, both kinds of programs can be more effective, and the full measure of savings can be captured by the utility.

The type of outreach that accompanies a traditional new construction program is fundamentally similar to the portion of a code support program targeting the design community. Additional training for the building department staff differentiates the scope of the code support program, but evaluation of energy savings would rely on the compliance rates in the field. Field inspection of energy code compliance is already required for participation in new construction incentive programs, and expanding that evaluation effort to include measures covered by the code training would be a cost-effective method of collecting the data necessary to support claiming energy savings for the code support initiative.

This approach is being investigated by utilities in other states. HMG is currently working with statewide utility groups in California and Massachusetts to pursue this program structure. By coordinating early with regulators, utilities can establish a pre-program agreement that will allow them to claim the energy savings from code compliance improvement.

Coordination of new initiatives with existing programs will also identify opportunities to leverage existing, established resources (e.g., special funds, education strategies, and marketing assets such as existing websites). Specifically, strategic coordination with active professional groups (such as SWEEP), state agencies (such as the Colorado Energy Office), and local code officials will improve best practices training of the building design community to meet and exceed minimum energy code requirements.

2. INTRODUCTION

In 2007, Colorado passed legislation requiring the 2003 IECC as the minimum energy code for all jurisdictions that adopt and enforce codes. Since Colorado is a home rule state there is no requirement for every jurisdiction to adopt or enforce energy codes. However, local enforcement agencies in jurisdictions that have adopted building codes are required to enforce the provisions of the energy code at the local level, but may adopt their own requirements or amendments without state approval. Building inspections are required as a part of the established energy code enforcement process. Some jurisdictions have updated their codes to comply with the state requirement, but lack real enforcement of the energy code. This lack of enforcement is generally a product of lacking the time or understanding to enforce the code.

The codes adopted in each local jurisdiction provide the baseline for calculating energy savings from utility-funded incentive programs. Lack of enforcement leaves new construction projects needing to *meet* the code before they can receive incentives for *exceeding* the code. In order to meet this need, for assistance with code enforcement and compliance, Xcel Energy funded a pilot that offered free training to building officials, HERS raters, and the design community on energy code topics identified by the building departments themselves. Six building departments volunteered to participate in this pilot, indicating a need for training on building energy code enforcement.

Training is not an entirely new arena for utilities; many utility-funded new construction energy efficiency programs incorporate trainings as one element of the program offerings. This pilot tested the theory that energy savings could be demonstrated solely as a result of a code training program, which has not yet been done successfully in the United States. This evaluation intended to answer the following questions:

- Will a tailored approach to code training and technical support help jurisdictions adopt new energy codes? Can we quantify additional energy savings?
- Will a tailored approach to code training and technical support help improve and accelerate code compliance? Can we quantify additional energy savings?
- Can the DOE Building Energy Codes Program (BECP) protocol be used cost-effectively to evaluate the Code Support pilot?
- Can we attribute savings to this pilot?
- What are the potential and achievable savings for the pilot jurisdictions?

Each jurisdiction participating in this pilot could potentially be enforcing a different energy code, each with unique submittal requirements. Each jurisdiction has its own design criteria for sizing residential equipment according to ACCA Manual J[2]. Most building departments have a

[2] ACCA Manual J Manual J Residential Load Calculation 8th Edition (MJ8) produces equipment sizing loads for single-family-detached homes, small multi-unit structures, condo-miniums, town houses and manufactured homes. For more information please refer to the Air Conditioning Contractors of America: https://www.acca.org/store/product.php?pid=172

"submittal guideline" that identifies what needs to be submitted with the plans in order to obtain a permit. Many of these submittal guidelines are either out of date or simply do not address the energy code provisions. Designers and contractors need access to jurisdiction specific information, however the submittal requirements are not always easily found on the building department's website. As a result, designers and contractors aren't always aware of the submittal requirements, and can turn in non-compliant documents, delaying the review and permitting processes.

The Colorado Department of Local Affairs (DOLA) has recognized this and offered free trainings to jurisdictions around the Denver region. However, some jurisdictions are worried the state might interfere with their codes and enforcement processes. Additionally the local International Code Council (ICC) chapter holds meetings every other month, providing code training to local members. Training at the national level provided by ICC is available but expensive; however the local ICC chapter gets one free training day per year. When a jurisdiction is getting ready to adopt a new code, the local ICC chapter often hires Colorado Code Consulting (CCC) to provide trainings. Building Owners and Managers Association International (BOMA) has also recently begun requesting training on the energy code. Despite these efforts, the demand for increased training on codes remains unfulfilled. Xcel Energy recognized the opportunity to support local jurisdictions to increase the energy efficiency of their buildings, and commissioned this pilot to determine whether energy code training can result in attributable savings, and recovery of utility expenditure on these programs.

2.1 Overview of Training Pilot Program

Xcel Energy created the Code Support Pilot, and hired CCC to develop and implement personalized energy code training for six (6) jurisdictions that volunteered to participate in the pilot. Each jurisdiction selected for this pilot received a personalized training plan based on their needs and interest. CCC staff met with each jurisdiction to establish specific training needs.

CCC provided training for residential plan reviewers, building inspectors, builders, designers, and contractors with the goal of receiving better plans with fewer resubmittals. The report by CCC provides more details about the training element of the pilot.

The training contractor (CCC) collected data from each jurisdiction including: training plan (who needs what training), training provided as part of this pilot, local contact information (name, title, phone number, address, etc.), who attended the training sessions, who needed IECC guidebooks, who received training documents, and the list of participants completing the training survey.

Xcel Energy and CCC identified three distinct stages of code enforcement and compliance that could warrant training and education to lead to increased code compliance; 1) submittal process, 2) plan review and 3) field inspections. Not all jurisdictions were trained in each area, but a baseline assessment of the status of each of these areas was identified for each jurisdiction and is provided in Appendix A: Training Plans.

2.2 Overview of Pilot Evaluation

The Heschong Mahone Group (HMG) was hired to conduct the evaluation of the pilot. The evaluation portion of this pilot commenced simultaneously with the implementation contractor establishing the specific training needs of each jurisdiction. This allowed the implementer and

evaluator to coordinate on the data collection approach before any training had been administered, allowing for a thorough and thoughtful approach to collecting the baseline information. The baseline assessment of current enforcement processes and compliance struggles was developed simultaneously along with the personalized training plan. This baseline assessment used a modified version of the BECP protocol, recording current practices/efficiency levels in actual projects, including an indication of compliance or non-compliance with the code currently in effect.

The original plan was to collect data for both commercial and residential permits. It became clear early on in the process that very few (if any) commercial projects were available for review, and clearly not enough consistency that would allow a sample of similar pre and post buildings and permits. As a result, only residential projects are included in this evaluation.

2.3 Overview of Pilot Target Audience

In order to achieve energy savings through increased compliance with the energy code, this pilot aimed to provide training for building departments, builders, designers, contractors and HERS raters. There are unique challenges in dealing with each of these groups. Below is a brief overview of some of the challenges encountered by building departments and members of the building industry.

2.3.1 Jurisdictions

Building departments can be particularly challenging to work with for a variety of reasons:

- No uniformity: varying priorities, staff background/expertise, perspectives and practices across (and even within) building departments.
- Staff autonomy
- Staff turnover
- Daily changes in workload and priorities
- Lack of funding

The building department itself is an independent entity that is allowed to set its own priorities and sometimes its own rules. This is particularly true in home-rule states. The chief building official sets the tone for how permitting, plan review and field inspections are conducted. There is little consistency among various building departments and if a building official leaves, the new person in charge may have different priorities and processes. Typically, a building department will have separate plan review staff and field inspection staff. For small jurisdictions, one employee could cover both of these roles. Building department staff typically maintain a great deal of autonomy; even within a single building department, staff carry out their jobs based on their level of expertise or comfort with the topic area. Therefore, the implementation of the processes can vary widely, even within jurisdictions.

Plan reviewers can often take as much or as little time as they want to review plans. Different jurisdictions have different requirements for the plan review process. In the course of conducting this pilot, the training vendor and the evaluator found that some jurisdictions do not require plan

reviews to be finalized and approved before conducting site inspections, at least up to the final inspection.

2.3.2 Building Industry

The building industry is notoriously unpredictable. There are many reasons why construction activity does not follow the planned schedule, including weather conditions, product delivery delays, labor turn-over and shortage, any of which can delay the construction process, and these impacts often snowball. Therefore timing of inspections is hard to schedule with certainty, making delays and callbacks common.

Building inspectors need to work around these real-world challenges within the confines of a local bureaucracy (City or County). They must follow the priorities of their department, while at the same time address critical issues in a timely manner.

Contractors

Contractors participated in trainings with CCC alone, and in conjunction with HERS raters. One issue raised was that contractors can't figure out what the design parameters are required for each jurisdiction, and would really like a compiled list posted on each building departments' website or a central location. There is a continued need for trainings for contractors to understand all of the code requirements and how to comply. Part of this requires building department staff to explain their reasons for rejecting plans or Manual J documents. Lack of consistency between Manual J and HERS reports is a common reason, but there are two distinct methods of calculating conditioned square footage that produces different answers.

HERS Raters

To try and adapt to increasing workloads and decreasing funding, many building departments rely on HERS raters for site inspections of Quality Insulation Installation (QII), duct testing and other energy compliance requirements. In many cases, building departments rely on Raters to perform final inspections for projects following the performance path for compliance, which requires a HERS inspection anyway. As independent consultants, Raters are also independent and unique with varying priorities and backgrounds. As a result building departments have little control over what the raters do inspect or their timeline.

There are two different business models in HERS companies. There are either HERS provider companies where each person that does the HERS ratings for those companies are all certified HERS raters or there are companies where the staff doing the ratings are not certified but they submit their documentation to the provider who is certified who then signs the documentation. While all raters are looking at the same components, the latter model offers less consistency. Other than this consistency issue, raters are doing a good job and jurisdictions can feel comfortable that the homes are being inspected to the approved plan.

3. APPROACH AND METHODOLOGY

The plan for this pilot evaluation was relatively straightforward: compare estimates of the compliance rates before and after Xcel-funded trainings were administered to determine the effectiveness of the training. Training plans were customized to the needs and desires of each jurisdiction to ensure that the training provided was relevant to the jurisdiction. The data collection and sampling approach across all jurisdictions was to collect all of the available inspection data using the U.S. Department of Energy Building Energy Codes Program (BECP) compliance checklist.

The pilot delivery method included the following steps:

- Choose pilot jurisdictions based on needs and interest and building activity.
- Baseline code compliance processes, and new code adoption plans via a self-assessment. Calibrate self-assessments across pilot jurisdictions.
- Build a training plan based on needs identified in self assessments and execute code training and technical support.
- Evaluate and quantify training impacts by conducting pre- and post-training surveys of participants, plan review, and field verification.

Several assumptions were made at the start of the evaluation study. Primarily, the evaluation plan expected that whole building compliance rates could be determined. We assumed that the compliance improvement could be applied to the expected energy savings of the applicable energy code being enforced at the local level, based on existing studies.

The success of the evaluation effort was predicated on the availability of data and the ability to see a difference in the compliance rates before and after training. One limitation to this evaluation was the shortened timeframe for collecting field inspection data, which supports the ultimate test of whether energy savings is achieved.

Data collection was coordinated with the training effort. There were two distinct phases of data collection: the baseline (pre-training) and the post-training phases. The data collection effort consisted of both plan reviews and field inspections. Ideally the data collection for each jurisdiction would include both plan review and field inspection for a sample of sites. However, due to the limited time available for data collection and the timing of the building permitting process, very few projects had both plan review and a field inspection data collected for this evaluation.

The data collection included: summary of training plan, BECP trainer/evaluator assessment, plan review results, field inspection results. Each jurisdiction received training at differing times, anywhere between late August 2012 and March 2013, so the timeline for the baseline and post-training phases was different for each jurisdiction.

3.1 Review Training Plans and Develop Evaluation Plans

In this task, the evaluator worked with the training vendor to document the following:

- Pre-training compliance baseline

- Training efforts
- Post-training compliance

The initial (planned) approach for the training and evaluation coordination called for development of training plans and evaluation plans for each jurisdiction. The training contractor (CCC) met with each jurisdiction to discuss their training needs and the evaluation team tailored the evaluation plan to focus on the jurisdiction-specific training provided to identify improved compliance as a direct result of the training.

CCC worked with each of the six jurisdictions between March and November 2012 to determine their training needs and develop a training plan. CCC had difficulty with some of jurisdictions in getting decisions and commitments on the training support. Ultimately, only three (3) of the six (6) jurisdictions received specific training directly on plan review or field inspection issues. The pilot intended to provide trainings about both the residential and commercial energy codes, but jurisdictions ultimately expressed interest only in the residential sector.

The training received by the jurisdictions covered the consistency of plans, compliance documentation, and Air Conditioning Contractors of America (ACCA) Manuals J, D and S for Residential HVAC load calculation, duct system design, and equipment selection, respectively.

Two jurisdictions received some education on the differences with the 2012 and 2009 IECC, to assist with their pending decision about which code to adopt. At the time of the writing of this report, neither of those jurisdictions indicated any plans to adopt the 2012 IECC.

3.2 Pre-Training Baseline Data Collection

Baseline data about the submittal process was collected by CCC, relying on interviews with building department officials in each jurisdiction and publicly available documents related to submittal requirements on their websites. Baseline assessments of the plan review and inspection processes were completed by CCC using the BECP compliance evaluation checklists for plan reviews and site inspections before training was complete.

3.2.1 Proposed/Planned Approach

The evaluation team was to create tailored data collection instruments, and provide written instructions to CCC. The proposed approach called for the evaluator to work with the Xcel pilot manager and CCC to select a sample of projects for plan review and field inspections. This level of detail/precision was not achievable based on the limited number of projects actually available. In the end, we got what we could.

The pre-training data collection was to be conducted by CCC using the BECP survey instrument. The DOE Building Energy Codes Program (BECP) has developed standard compliance checklists[3] for conducting building evaluations based on a review of the plans and actual

[3] http://www.energycodes.gov/compliance/evaluation/checklists.

construction in the field. The Score + Store™ tool, developed by BECP to aid states and local jurisdictions in storing building sample data gathered as part of a compliance evaluation, was used to consistently calculate the compliance score. The tool automates the reporting process, helping to align data gathered across the jurisdictions.

The proposed approach to identifying a building sample for this pilot was more relaxed than the BECP protocol recommendation, and looser than most evaluation requirements. A "catch-as-catch-can" approach to collecting project data was agreed upon to gain as much data as was available within the time limits for the pilot. The minimum goal was to collect data for at least three single family new construction projects in each jurisdiction for each time period: pre-training and post-training. The resulting checklists were to be input into the Score + Store™ Tool, to estimate a compliance rate for each project, and then an average compliance rate across all of the data uploaded for each jurisdiction. These results would provide a snapshot of the compliance rate with the energy code.

3.2.2 Actual Approach

The actual approach to data collection utilized the 2009 IECC Residential Checklist developed by the BECP for compliance evaluation, as planned. Data was collected by CCC for all projects that were available during the pre-training assessment; including on-site inspections as well as plan reviews. The condensed timeframe for this pilot precluded the ability to identify a desired sample of buildings. Instead the approach relied on all data for single family new construction projects available for both plan reviews and building inspections at the time of pre-training data collection. A similar approach was taken for post-training data collection.

We were able to meet the minimum goal of at least three single family new construction projects in each jurisdiction. Data collected in the checklists were input into the Score + Store™ Tool to estimate a compliance rate. After entering the data, HMG contacted the DOE Score + Store™ lead in April of 2013 who explained that there is a revision planned to improve how the tool estimates compliance rates. Therefore the snapshot of compliance rates with the energy code presented in this report are based on the weightings and calculations inherent in the Score + Store™ tool publicly available as of May 1, 2013. This is discussed in greater detail in the Data Analysis section.

3.3 Post-Training Data Collection

After training was conducted, similar data was collected to assess the effectiveness of the training provided to the jurisdiction and estimate any improvement in compliance.

3.3.1 Proposed/Planned Approach

The post-training data collection was conducted by the evaluators, using the same data collection instruments that were used for the pre-training data collection. The evaluation data collection effort consisted of both plan review and field inspections of all projects that were available during the post-training assessment for each jurisdiction.

After the data were collected, they were input in the Score + Store™ tool to calculate the compliance rates of each project.

3.3.2 Actual Approach

HMG limited the post-training data collection to the three jurisdictions where the impact of the trainings was expected to produce measurable results. The outreach to the other three jurisdictions is not expected to have produced a measurable impact on energy code compliance.

HMG coordinated with HERS raters and building department staff at each jurisdiction to accompany inspectors on field inspections and collect data to fill out the BECP 2009 IECC Residential checklists. Field inspection data was supplemented by information provided on plans, compliance documentation and/or Manual J submittals for those projects when available.

The sampling of sites was limited to those receiving field inspections at the time of HMG's visits to Colorado[4]. In addition to sites receiving field inspections, checklists were filled out for additional projects based on plans that had been reviewed by building department staff after training was provided to plan reviewers in that jurisdiction, when available.

Due to the condensed timeframe of this pilot and the inherent time lag between plan submittal, review, construction and inspection, most projects that received field inspections as part of the post-training data collection were based on plans that had been reviewed prior to the plan reviewer training. Therefore, there was not sufficient opportunity to collect field data from a project that had gone through the plan review process after the plan reviewers in that jurisdiction had received training as part of this pilot. One jurisdiction was able to conduct field inspections of projects whose plans had been recently reviewed due to their unique permitting process, which allows permits to be issued prior to the completion of the energy code compliance review as explained in Section 4.3.

The post-training data collection effort was able to meet the minimum goal of at least three single family new construction projects in each jurisdiction being evaluated. Post-training data was input into the Score + Store™ Tool to estimate a compliance rate, as planned.

3.4 Data Analysis

The pre and post training data was to be used to assess the effectiveness of the training as indicated by the training elements being checked and properly verified during plan reviews and field inspections and to assess overall compliance rates.

During the course of the data analysis, the evaluators concluded that without substantial information on compliance rates, and the compliance rate improvement, it would not be possible to conclusively determine the overall improved compliance rate nor estimate potential energy savings.

[4] HMG made two separate trips during 2013 to Colorado to collect post-training data. The first was February 17-22; the second was March 20-29.

3.4.1 Proposed Approach

The evaluator planned to use the pre-training data to develop baseline compliance rates for each jurisdiction. This includes using the training plan and expected accomplishments documentation to identify the training objectives and determine whether those objectives were met. The evaluator would compare pre and post training results, at both the plan review and field inspection level, to determine an increase in compliance rates or any other indication of improved code compliance as a result of the training.

Comparing results of the jurisdictions' BECP evaluations to both the pre- and post-training plan review and field inspection data would determine whether the BECP protocol can be used to evaluate the code support program energy savings. Energy savings would be quantified according to the change in compliance rates based on the data collected using the BECP protocol.

3.4.2 Actual Approach

HMG used the data collected during the pre- and post-training phases of the pilot to develop estimates of compliance rates with the energy code by inputting the checklist data into the Score + Store™ tool. As noted above, we decided to continue using the Score + Store™ tool to estimate compliance rates after speaking with the DOE Score + Store™ lead in April of 2013, who revealed that the tool is undergoing a revision to improve how it estimates compliance rates. Our rationale was that the compliance rates provided would remain comparable to each other, with additional analysis being required anyway to tell the complete story.

Measures most commonly observed, as either compliant or non-compliant, are identified. This highlights the measures on the checklist that provide the basis for the calculated compliance rates. The analysis of measures observed is presented for each jurisdiction, with a description of how this impacts the credibility of the compliance rates being compared. It is important to note that determination of whether an individual line item on the checklist is considered "compliant" or not is based on the comparison of information provided with the prescriptive code requirement, even for projects using the performance compliance path. The information reported from Score + Store™ includes:

- Measures Not Observed – This is a count of how many measures were not observable from the available data for each project in the sample. This count does not include measures that were found to be compliant or non-compliant, or measures which were not applicable.
- Points Received – This is a summation of the measures that were found to be in compliance, weighted by each measure's energy impact according to the Score + Store™ methodology.
- Total Points Possible – This is a summation of all the measures that were observed multiplied by their weighting, to produce the maximum points possible if all observable measures were found to be in compliance with 2009 IECC.
- Score – This is calculated by dividing the Points Received by the Total Points Possible. The score represents the percent of observable measures that were found to be in compliance, weighted by their energy impacts.

In addition to calculating compliance rates, HMG examined how procedures changed as a result of the training, which can produce long term code compliance improvement and energy savings that do not show up in this short term evaluation of compliance rates.

4. TRAINING ASSESSMENT

This section provides an overview of the training provided to each jurisdiction. The goal of the evaluation effort is to determine whether the training:

- made any difference on compliance of specific measures
- improved compliance overall

The emphasis of the training was on documentation consistency so that plan reviews are more efficient and complete information is available for field verification. As an example, the training brought together HVAC contractors and HERS raters and explained the importance of consistency of values used in both the Manual J load calculations and HERS report, such as conditioned floor area, insulation values and glazing U-factors. The HVAC load calculations, based on ACCA Manual J, could potentially lead to reduced equipment size installation if based on specific and correct information.

Air Conditioning Contractors of America (ACCA) developed a series of manuals to help contractors with the design, sizing and installations of HVAC equipment[5]. The relevant manuals for residential applications in Colorado counties are Manuals J, S and D. Sequentially; contractors first utilize Manual J to calculate the heating and cooling loads on the equipment, depending on design temperatures as well as various building characteristics. The intent of Manual J is to fully accommodate occupant comfort and ensure efficient and reliable equipment operation as designed. This is accomplished by "right" sizing the HVAC equipment to meet the calculated loads. Manual J requires inputs on items that impact the energy consumption of the house; items with the highest impact are fenestration characteristics, duct location and insulation and envelope characteristics such as roof, wall and floor insulation levels.

After determining the loads, the contractor then references Manual S and manufacturers' applied performance data to size and select equipment for the job, based on the load calculation performed following Manual J. Manual S provides equipment sizing guidelines, and also includes a method for calculating the necessary design air flow (in cfm) needed for Manual D. After selection of proper heating and cooling equipment the contractor uses Manual D to layout and size the duct system that will be installed. It is important to use Manual D because properly designing the network of ducts to deliver the conditioned air is critical to ensuring occupant comfort and satisfaction with installed systems. Utilizing main inputs including the required air flow and external static pressure specifications of the selected equipment, Manual D helps define the pressure drop experienced within the duct system, calculate the duct lengths, and inform the trunk and branch sizing, material selection and duct path design.

[5] More information about the Air Conditioning Contractors of America and the manuals they have developed is available on their website at https://www.acca.org/

4.1 Summary

Currently there is not enough consistent data through design and construction to determine with any confidence that the HVAC equipment size is 1) based on the load calculations or 2) would result in reduced equipment sizing even if the load calculations were followed. Currently, the industry uses standard rules of thumb for equipment sizing and oversizing safety factors. These practices are very slow to change. Understanding and enforcement of the code requirements by the building department staff is the first step in the long process of changing current rule of thumb practice to better designed systems.

If designers and contractors perform Manual J load calculations, Manual S equipment selection and Manual D duct sizing according to actual building components and conditions, then the resulting installed system would be properly sized for the building. As building envelope requirements are tightened over time, based on code requirements or current practice, the resulting loads and equipment specifications would decrease.

There is a need for on-going and sustained training opportunities with the plan review process. Training and education are needed to increase core knowledge of specific items, such as use of proper climate data and how to review Manual J. Increased understanding of code, ACCA Manuals J, S and D, and energy documents will improve the confidence, speed and efficiency of plan reviewers.

Thorough training will increase the plan reviewers understanding of code and confidence in submittal requirements and should reduce or eliminate incorrect submittals. It is important to provide regular training to keep staff up-to-speed on submittal requirements and code changes so that staff efficiency and knowledge of the permitting process continues to increase. Lack of in-depth understanding of submittal guidelines or reasons for requirements have led to inconsistent plan review processes.

There is also a general lack of field knowledge of energy code requirements. Most homes being constructed in these jurisdictions (almost 90%) utilize the Performance Path as their approach to complying with the IECC. As a result, field inspections tend to rely on the HERS rater for the energy code elements of the inspection. The raters were often focusing on measures that fed into the HERS score, but not checking for mandatory code requirements. Additional trainings were conducted with the HERS raters reviewing the mandatory items of the code that cannot be traded off under the performance path. Improved field knowledge will result in better understanding of energy compliance documentation and the approval process

While the evaluation results are inconclusive as to whether additional energy savings can be achieved, our follow up conversations with trained building department staff suggests that better training of staff will result in more confidence, allowing them to request additional information from builders. Once builders know that the building departments are requiring complete energy compliance submittals and they understand those requirements, they will submit complete and consistent documentation. These two inter-related efforts will produce better overall code compliance.

The subsequent sections summarize the baseline assessment and training opportunities for each jurisdiction participating in the pilot.

4.2 Jurisdiction A

4.2.1 Plan Submittal and Review Process

Jurisdiction A requires energy compliance, Manual J, and ResCheck reports at time of plan submittal. The plan reviewers do not compare all energy documents together for consistency. Mechanical verification forms are inconsistent with other energy code compliance documentation. The problem is that the plan reviewer lacks the knowledge of Manual J and therefore, also the confidence to provide a full review and ask questions about submittals. The plan reviewers do not review Manual S or D.

CCC's training opportunity was to increase knowledge of Manual J, S and D among plan review staff resulting in a better plan review process including a comprehensive plan review as well as field training on Manuals J, S and D. The training would also increase the accuracy of plan submittals by the builders once they knew that the building department was requiring and plan reviewing this information.

Specifically the training would:

- provide training to plan reviewers to check for consistency in documentation
- provide training on the integration of, and coordination between, code compliance verification requirements

4.3 Jurisdiction B

4.3.1 Plan Submittal and Review Process

Jurisdiction B has specific energy code requirements and robust submittal guidelines. Despite this, designers are not calling out on their plans the required information such as air leakage details, window U-value schedules, duct sealing methods, duct insulation details, and thermal envelope designation. Additionally, the contractors are not following the submittal guidelines and commonly submit data based on best practices instead of code requirements.

The plans, performance compliance report, Manual J calculations, and any other energy documents are not consistent. Contractors and designers are not providing the required information on the plans and are not submitting all paperwork required to receive permits. Contractors are not turning in all of the correct paperwork to get their permit such as the Manual J plus the ResCheck or Performance Report plus the Duct layout, etc., even though it is specifically called out in the submittal requirements sheet for this all to be turned in at the same time.

CCC's training opportunity to educate contractors and designers included the following:

- submittal requirements and guidelines (as opposed to current practices), particularly HVAC sizing requirements, including how to complete the proper paperwork
- plan labeling requirements
- proper and acceptable methods for load calculations, including correct usage of Manual J programs and correct climate data

CCC provided collective training to mechanical contractors, HERS raters and designers about the necessity for consistent documentation, QA/QC of the required documents, and increased coordination among the required documents. The training effort focused on having mechanical contractors, HERS raters and designers all in the same room at the same time to go over all of Jurisdiction B's specific information as well as the code required information that must be submitted at the time of permit application to get them all on the same page.

The desired outcome of the training was:

- contractors adhere to submittal guidelines, resulting in a reduction in the number of incorrect submittals, faster application approval time, and reduced paperwork and time for code officials
- plan reviewers review submitted energy documents consistently according to the submittal guidelines
- contractors submit consistent energy documents
- more accurate Manual J calculations, better system design and performance, proper climate data, resulting in reduced paperwork for code officials and smaller HVAC equipment installed in the field

4.3.2 Plans Analysts and Plan Review Process

There were additional training opportunities with the plan review process. Training and education are needed to increase core knowledge of specific items, such as the use of proper climate data and how to review Manual J documentation. Thorough training will increase the plan reviewers understanding of code and confidence in submittal requirements and should reduce or eliminate incorrect submittals. It is important to provide regular training to keep staff up-to-speed on submittal requirements and code changes so that staff efficiency and knowledge of the permitting process continues to increase. Lack of in-depth understanding of submittal guidelines or reasons for requirements have led to inconsistent plan review processes.

The building department allows permits to be issued prior to the completion of the energy code compliance review; however, the final permit is not issued until after the plan review is complete and approved. The load calculations must meet the ACCA Manual J requirements and the Duct Design must meet the ACCA Manual D requirements for sizing. Best practice would be for Manuals J and D to be reviewed before site installation to allow for corrections.

The plan reviewers are not ensuring that the documentation from the HERS rater and the mechanical contractor are consistent. For example, HERS reports and Manual J documentation are not being checked for consistent values such as building square footage and R-values/U-factors.

CCC identified the following training opportunities for plan reviews:

- provide training to contractors and designers on properly sizing HVAC equipment. Remind contractors and designers that Manual J and Manual D must meet code requirements before they can receive the rough inspection
- review Manual J and D submittals when they come in, so that modifications or corrections can be made before equipment has been installed

- conduct code-specific training that connects compliance with the mechanical requirements to the permitting process
- increase understanding of code, Manual J and D, and energy documents to improve confidence, speed and efficiency of plan review
- Train plan reviewers to check for inconsistencies between rater and contractor documents. Plan reviewers can then educate raters and mechanical contractors on the critical components of documents that must match. This effort results in consistent values being used by HERS raters and mechanical contractor, better QA/QC by the plan reviewer, and reduced correction time for building officials.

CCC created plan review tools (checklists, etc.) as reminders to look at all requirements, including Jurisdiction B specific requirements.

4.4 Jurisdiction C

4.4.1 Plan Submittal Process

CCC identified the following issues with plan submittals in Jurisdiction C:

- The plans, Performance Compliance Report, Manual J, and other energy documents do not match each other. Information is inconsistent across submitted documents. Lack of coordination among submitting team and/or need for quality check within specific firms.
- Mechanical contractors manipulate Manual J programs, causing mistakes and inconsistencies. Mechanical contractors use Manual J programs incorrectly.

Based on these issues, CCC developed the following training opportunities for the industry:

- Develop contractor/designer specific checklists and provide training to builders on energy code requirements.
- Provide collective training to mechanical contractors, HERS raters and designers on how to cross reference manuals, guides and code requirements, and use consistent values across submitted documents for consistent documentation, QA/QC, and increased coordination
- Train mechanical contractors and code officials on correct usage of Manual J programs
- Train contractors on choosing properly sized equipment and on properly verifying equipment sizing using the software.

The expected outcomes of the trainings were:

- Consistent energy documents submitted
- More accurate Manual J calculations, better system design and performance, reduced paperwork for code officials, smaller equipment sizes installed

4.4.2 Plans Analysts and Plan Review Process

CCC identified the following issues with the plan review process in Jurisdiction C:

- Poorly defined guidelines for energy code requirements. There is a need for checklists to facilitate energy code review.
- Poor submittal requirements leads to inconsistent documentation submittal
- Values are inconsistent across submitted documents. Lack of understanding or lack of coordination among submitting team and/or need for quality control within specific firms.
- Plan reviewers do not understand how to read and enforce Manual J requirements
- Contractors are installing improperly/over- sized equipment.
- Manual D and S are not required
- Lack of understanding by plan reviewer for reviewing ResCheck and performance compliance reports for accuracy.
- Inconsistent enforcement of compliance options for air leakage requirement

Based on these issues, CCC developed the following training opportunities:

- Train building officials/plan reviewers on value of cross referencing requirements between reports
- Provide collective training to mechanical contractors, HERS raters and designers on how to cross reference manuals, guides and code requirements, and use consistent values across submitted documents
- Train code officials on ALL required compliance reports, submittal procedures and timelines.
- Provide checklists for energy code review and training on how to properly complete and review checklists.
- Train Plan Reviewers on how to read Manual J and catch errors in load calculations or equipment sizing.
- Train contractors on choosing properly sized equipment and on properly verifying equipment sizing using the software.
- Train plan reviewers on how to read Manual D and S and catch errors
- Train building officials on value of consistent enforcement and how to perform blower door test or visually inspect homes

The expected outcomes of the trainings are:

- Correctly submitted documents results in shorter review time
- Consistent energy documents required by plan reviewers, catch oversizing mistakes and loopholes
- Plan reviewers enforce correct Manual J requirements, right-sized equipment gets installed in buildings
- Manual D and S require that an enforced, right-sized equipment gets specified and installed

- More consistent, complete enforcement of air leakage requirements result in tighter buildings

4.5 Jurisdiction D

The only training received by Jurisdiction D was for their Building, Mechanical and Electrical Inspectors to be certified by ICC as Energy Code Inspectors. A total of 31 inspectors participated in the training, with nine getting certified after attending the training. Of the nine that got certified, six used their own funds to pay for the test, while three relied on funding from Xcel Energy. Results of the training to be certified as Energy Code Inspectors is available as part of the Colorado Energy Code Support Pilot Study report developed by Colorado Code Consulting, LLC.

4.6 Jurisdiction E

Training for Jurisdiction E was originally planned to cover the 2009 and 2012 IECC, to help inform their decision to move up from the 2006 IECC. Staff turnover at the building official position delayed their training past the date at which they could be included in this pilot.

4.7 Jurisdiction F

Jurisdiction F was planning to move to the 2012 building codes, but wanted to stay on the 2009 energy code. Despite trainings on the 2009 and 2012 energy codes, Jurisdiction F indicated their intent to remain on the 2009 energy code as of the conclusion of the pilot. Additional follow up is needed to encourage adoption of the 2012 energy code.

4.8 HERS Raters

CCC conducted a training session with major HERS raters in Colorado, June 29, 2012. This section summarizes the results of the training.

4.8.1 Contractor training needs according to HERS raters

During the training HERS raters identified areas where they saw a need for contractor training because of a consistent lack of compliant installation or process as it refers to the requirements of the IECC/IRC. The primary areas were insulation and air barriers. The HERS raters identified the following training needs.

Insulation contractors need training on correct insulation installation and the requirements of the code. If they are using the performance path, they can get a low HERS score for their installation (not necessarily installed correctly) and can make it up somewhere else in the building. Many building departments look in IECC Chapter 3 where it states that all insulation shall be installed to manufacturer's installation instructions. This section is mandatory so even though they are allowed some leniency in the performance path using RemRate, the code is not lenient and installers need to know of the requirement and to be shown better installation techniques.

There are a lot of different framing assemblies that are not being handled correctly when it comes to air barriers and insulation. Special framing situations cause confusion on where the air barrier goes and how insulation is installed and inspected. Some training is needed for both

contractors and code officials on some different framing situations and how they can comply. Cross training with the other trades on air barriers and insulation requirements would also be good. Plumbers, mechanical contractors and framers often come in after air barriers and insulation have been installed and ruin a good install because they don't understand how it all works nor the code requirements outside of their own trade.

They suggested that there should be more training for contractors, designers and code officials on how the house works as a system so that they understand how the envelope, mechanical, and lighting systems all affect each other.

They also suggested a comparison of prescriptive and performance paths; where a prescriptive house, built to the 2009 IECC prescriptive path, would be run through the performance path to see if the prescriptive and performance paths are truly equal.

4.8.2 Suggestions for achieving more coordination between trades

During the training the HERS raters were asked to provide suggestions for achieving more coordination between trades.

The raters said that some jurisdictions hold preconstruction meetings for each project, where they have someone from the different trades present to walk through the project and inspection process prior to issuing a permit. This is helpful and could be a place where contractors could learn of the requirements of the other trades. This could be a really valuable idea, but it is unclear whether an Xcel-funded program could provide incentives to facilitate such a meeting.

The raters also suggested that educating the trades in the same training so that they can listen to each other's requirements as well as comments would be helpful. Educating the inspectors so that during their inspections they can provide education to the contractors while they are there would be very beneficial.

5. COMPLIANCE ASSESSMENT RESULTS

The goal of this assessment is to determine whether the training provided to the jurisdictions made any difference in the compliance of specific measures, and whether compliance with the 2009 IECC improved overall.

This section provides an overview of the compliance rates calculated for each jurisdiction before and after receiving training, using the Score + Store™ online tool. The analysis of measures observed is presented for each jurisdiction, with a description of how this impacts the credibility of the compliance rates being compared. Due to time constraints, too few projects were included in the sample to produce statistically robust results. Additionally, not all code measures were able to be observed on plans or verified in the field. Rather the calculated compliance rates provide a snapshot of the compliance levels of observable measures for each jurisdiction. It is important to note that determination of whether an individual line item on the checklist is considered "compliant" or not is based on the comparison of information provided with the prescriptive code requirement, even for projects using the performance compliance path. The information reported from Score + Store™ includes:

- Points Received – This is a summation of the measures that were found to be in compliance, weighted by each measure's energy impact according to the Score + Store™ methodology.
- Total Points Possible – This is a summation of all the measures that were observed multiplied by their weighting, to produce the maximum points possible if all observable measures were found to be in compliance with 2009 IECC.
- Score – This is the Points Received divided by the Total Points Possible. The score represents the percent of observable measures that were found to be in compliance, weighted by their energy impacts. There is no explicit penalty if measures are not observed.

5.1 Summary

Figure 3 shows the weighted overall compliance rate for each jurisdiction, pre and post-trainings. The number of sites that provided the data that make up that compliance rate is also included in the table.

The compliance rate with the 2009 IECC is based on the measures that were observable at the time the data were collected, which depends on the phase of construction. The values given for each site detail the points awarded versus the points possible. The points possible are based on the specific measures observed, weighted by the expected energy impact of these (Tier 1, 2, or 3). For example, a Tier 1 measure such as verifying that the HVAC equipment is sized per ACCA Manual S, based on loads per ACCA Manual J, has more weight than a Tier 3 measure such as verifying that building cavities are not used as ducts or plenums, and is therefore awarded more points for compliance.

Due to the small sample sizes, the statistical confidence of the compliance rates being reported is very low. Additionally, the compliance rates being reported are relatively high, ranging from 87.0% to 96.3%. These compliance rates are calculated based on measures that were observed at

the time of the evaluation. Measures that are not available for observation are not considered in the calculation of the overall compliance rate, and therefore do not improve or penalize the compliance score. Each of the following sections discusses the measures that were observed as part of the pre- and post-training evaluations for each jurisdiction. Additionally, the relatively high compliance rates are based on relatively few samples, which may not necessarily be representative of general practices in each jurisdiction.

Jurisdiction	Pre-Training		Post-Training	
	Number of Sites	Weighted Overall Compliance Rate	Number of Sites	Weighted Overall Compliance Rate
Jurisdiction A	13	90.5%	13	95.3%
Jurisdiction B	13	87.0%	9	92.8%
Jurisdiction C	6	96.3%	11	93.7%

Figure 3: Summary of Weighted Overall Compliance Rates pre- and post-training

Figure 4 provides the estimated annual energy savings per single family house in each jurisdiction based on the change in compliance. We calculated the approximate energy savings based on the change in overall compliance rate, assuming that non-compliant measures met the 2006 IECC instead the 2009 requirements. The methodology for this savings estimation is described in greater detail in Section 5.5.

Jurisdiction	A	B	C
Compliance delta	4.8%	5.80%	-2.6%
Savings (kWh)	18.9	22.9	(10.3)
Savings (Therms)	5.0	6.1	(2.7)

Figure 4: Estimated Annual Energy Savings per single family house per Jurisdiction

Since Jurisdiction C was found to have a negative change in compliance rate (i.e. the compliance rate decreased after training), the energy impact is estimated as a negative number. We surmise that the negative change in compliance rate is likely indicative that the pre-training compliance rate was already very high (greater than 96%) based on a small sample size (six sites) where non-compliant measures were unable to be observed, therefore boosting the compliance rate as

compared to the post-training sample. Further discussion of this result is provided below in Section 5.4.

5.2 Jurisdiction A

Figure 5 shows the weighted overall compliance rate in Jurisdiction A increased by almost 5% between the pre-training and post-training samples. This potentially represents increased savings of 18.9 kWh and 5 therms per house on average. There were a total of 13 sites evaluated in each dataset. All of the pre-training data was based on field inspections, while two of the 13 post-training evaluations were based on plan reviews; the rest are based on field inspections.

Time frame	# of projects	Overall Compliance Rate
Pre-Training	13	90.5%
Post-Training	13	95.3%

Figure 5: Jurisdiction A Weighted Overall Compliance Rates pre- and post-training

Figure 6 and Figure 7 provide the weighted overall compliance rates as calculated by Score + Store™ for each site from the pre-training and the post-training samples, respectively. The compliance rate with the 2009 IECC is based on the measures that were observable at the time the data were collected, dependent upon the phase of construction. The overall compliance rates reported in Figure 5 are calculated by dividing the Total Points received by the Total Points Possible. By taking the ratio between the sum of all Points Received and the sum of all Total Points Possible, the weighted average reduces the bias introduced by individual site scores with limited/low numbers of observed items. For example, in Jurisdiction A, construction drawings and documentation were only observable at four sites in the pre-training sample, with none fully demonstrating compliance with the energy code. The post-training sample only had 3 sites with construction drawings and documentation available for review, with two of those three demonstrating compliance. Similarly, the heating and cooling equipment type and capacity was found to be installed as per plans at six of seven sites for which it was observable in the pre-training sample, but only one observation (compliant) was possible in the post-training sample.

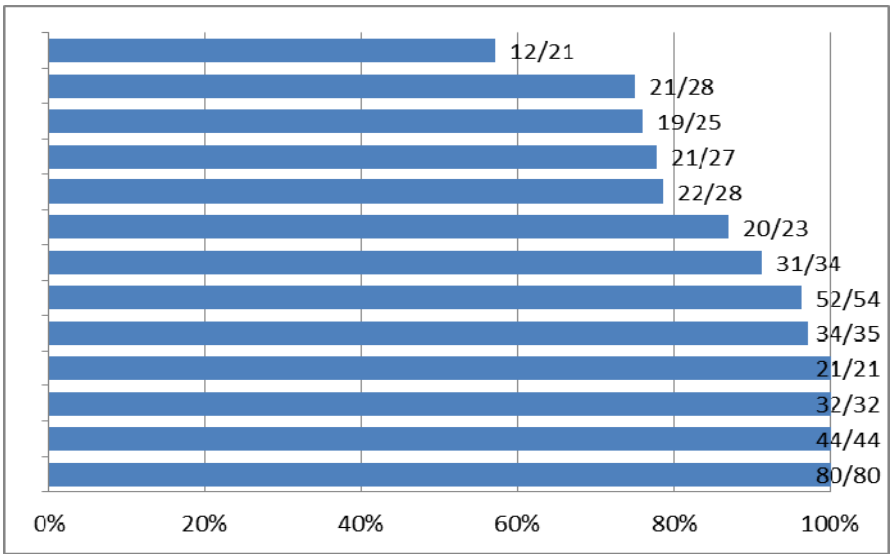

Figure 6: Jurisdiction A Pre-Training Compliance Rate per Site (13 sites)

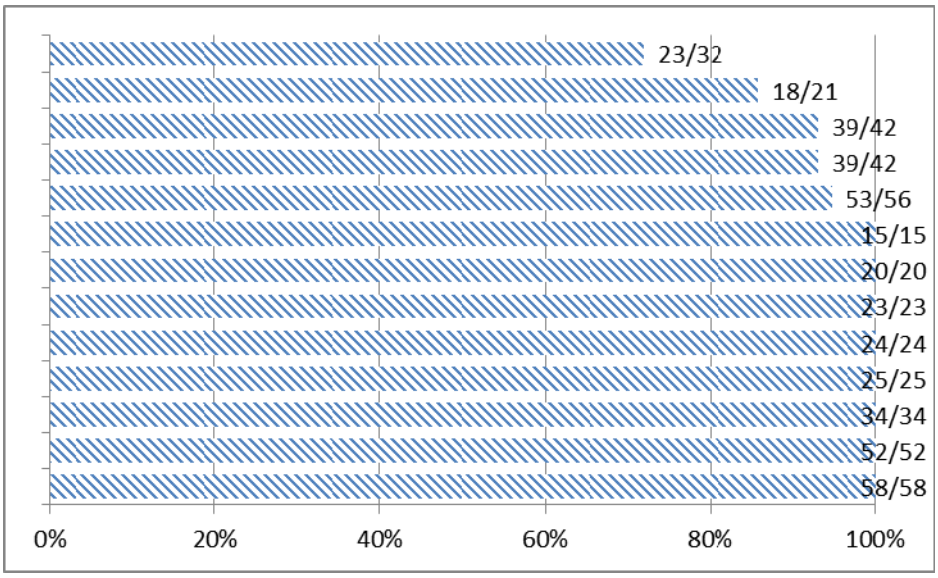

Figure 7: Jurisdiction A Post-training Compliance Rate per site (13 sites)

Overall, the 13 sites included in the Jurisdiction A pre-training sample have a weighted compliance rate of 90.5%, with four of the 13 (31%) projects showing 100% compliance. The measures most commonly observed were all related to envelope infiltration/leakage, and were also the measures with the highest (100%) rate of compliance:

- Dampers installed on all outdoor intake and exhaust openings
- IC-rated recessed lighting fixtures meet infiltration criteria
- Glazing U-factor and SHGC values
- Duct sealing complies with listed sealing methods

- Basement wall interior insulation R-value

The measure with the lowest rate of compliance (0% at four sites observed) was:

- Construction drawings and documentation available / Documentation sufficiently demonstrates energy code compliance

The following measures all had at least one site not in compliance:

- HVAC load calculations consistent across Manual J and ResCheck or REMRate
- Slab edge insulation depth/length
- Wall insulation R-value
- Heating and cooling equipment type and capacity as per plans

Only three of the 13 pre-training sites evaluated had Manual J calculations available on site. The rest of the sites either did not have Manual J calculations onsite, or the calculation results were found to not match equipment installed in the field. Partially due to the pre-training observations, the training for Jurisdiction A plan reviewers focused on Manual J load calculation requirements.

The 13 sites included in the Jurisdiction A post-training sample have a weighted overall compliance rate of 95.3%, with eight of the 13 (62%) projects showing 100% compliance. The most commonly observed measures were:

- Glazing U-factor (area-weighted average), and SHGC
- Floor and wall insulation R-values
- Conditioned basement wall interior insulation R-value
- All installed insulation labeled or installed R-value provided

The measures with the highest (100%) rates of compliance were:

- Glazing U-factor (area-weighted average), and SHGC
- Conditioned basement wall insulation R-value and depth
- Ceiling insulation R-value
- All installed insulation labeled or installed R-value provided

The measures with the lowest rates of compliance were:

- Fenestration and doors labeled for air leakage
- Duct tightness via post-construction with maximum leakage
- Wall insulation R-value

Only one project was able to verify that heating and cooling equipment type and capacity were installed as per plans. There were also very few instances of HVAC load calculations or other construction documents being available in the field to verify whether construction was following the approved plans.

Three of the 13 post-training projects evaluated were plan reviews; two of which demonstrated relatively accurate and consistent Manual J documentations. One project did not provide adequate and consistent design details for Manual J calculations. However, the plan reviewer for Jurisdiction A noted on the construction plans several design parameter and schedule inconsistencies and suggestions on how to correct them. This appears to indicate the training successfully taught the plan reviewer enough about Manual J load calculations to feel confident to reject incorrect or inconsistent submittals.

5.3 Jurisdiction B

Figure 8 shows the weighted overall compliance rate increased by 5.8% after trainings were administered to Jurisdiction B plan reviewers. This potentially represents energy savings of 22.9 kWh and 6.1 therms per house on average. The reasons for the compliance rate improvement are explained below.

Time frame	# of projects	Overall Compliance Rate
Pre-Training	13	87.0%
Post-Training	9	92.8%

Figure 8: Jurisdiction B Weighted Overall Compliance Rates pre- and post-training

The tables in Figure 9 and Figure 10 provide the weighted overall compliance rates of each of the sites from the pre-training and the post-training samples. The compliance rate with the 2009 IECC is based on the measures that were observable at the time the data were collected, which depends on the phase of construction. Each site has a compliance rate based on the number of points received (for compliance measures) divided by the total points possible (for all measures observable). In Jurisdiction B, the following measures that are related to the trainings provided but were not observable during inspections include:

- Construction drawings and documentation available; Documentation sufficiently demonstrates energy code compliance (only three observations in the post-training sample, zero observations in the pre-training sample)
- Heating and cooling equipment type and capacity as per plans
- Duct sealing complies with listed sealing methods; Duct tightness via rough-in or post-construction test

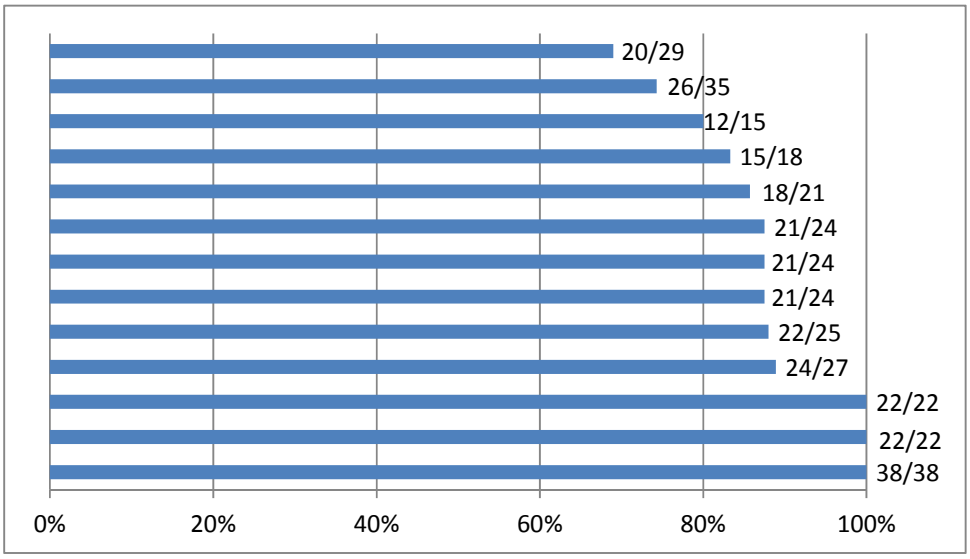

Figure 9: Jurisdiction B Pre-training Compliance Rate per site (13 sites)

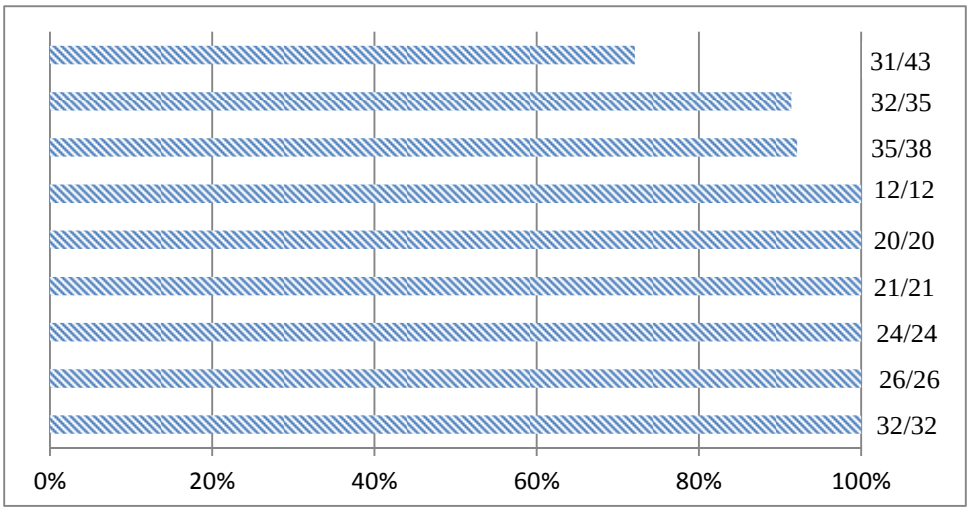

Figure 10: Jurisdiction B Post-training Compliance Rate per Site (9 sites)

Overall, the 13 projects included in the Jurisdiction B pre-training sample have a weighted overall compliance rate of 87%, with three of the 13 (23%) showing 100% compliance. The most commonly observed pre-training items were:

- Glazing U-factor (area-weighted average)
- Attic access hatch and door insulation
- Wall insulation R-value and ceiling insulation R-value

The items with the highest pre-training compliance rate (which had 100 percent compliance and were also most frequently observed) were:

- Glazing U-factor (area-weighted average)

- Attic access hatch and door insulation
- Ceiling insulation R-value

The items with the lowest pre-training compliance rates (which were frequently observed with lower rates of compliance) were:

- Wall insulation R-value, which was in compliance only 2 of the 12 times it was observed
- Floor insulation R-value

Overall the nine projects included in the Jurisdiction B post-training sample have a weighted overall compliance rate of 92.8%, with six of the nine (67%) showing 100% compliance. The most commonly observed post-training measures are:

- Conditioned basement wall insulation R-value
- Glazing U-factor and SHGC values (area-weighted average)
- Ceiling insulation R-value

The measures with the highest post-training compliance rates are:

- Conditioned basement wall insulation R-value
- Ceiling insulation R-value
- Conditioned basement wall insulation depth from the top of the wall

The measures which display the lowest rates of compliance for post-training sites are:

- Heating and cooling equipment type and capacity sized per ACCA Manual S based on loads from ACCA Manual J

Jurisdiction B was able to provide recently reviewed plans for seven sites, three of which were inspected in the field. This is due in part to the fact that Jurisdiction B allows permits to be issued prior to the completion of the energy code compliance review; however, the final permit is not issued until after the plan review is complete and approved.

5.4 Jurisdiction C

Figure 11 shows the weighted overall compliance rates decreased by 2.6% between the pre-training and post-training samples. We surmise that the negative change in compliance rate is likely indicative that the pre-training compliance rate was already very high (greater than 96%) based on a small sample size (six sites) where non-compliant measures were unable to be observed, therefore boosting the compliance rate as compared to the post-training sample. A comparison of the types of measures is detailed below.

Time frame	# of project	Overall Compliance Rate
Pre-Training	6	96.3%
Post-Training	11	93.7%

Figure 11: Jurisdiction C Compliance Rates pre and post-training

The tables in Figure 12 and Figure 13 provide the weighted overall compliance rates of each of the sites from the pre-training and the post-training data collected. The compliance rate with the 2009 IECC is based on the measures that were observable at the time the data were collected, which depends on the phase of construction. In Jurisdiction C, the following measures that are related to the trainings provided but were not observable during inspections include:

- Construction drawings and documentation available; Documentation sufficiently demonstrates energy code compliance (only two observations in the post-training sample, zero observations in the pre-training sample)
- Heating and cooling equipment type and capacity as per plans
- Duct sealing complies with listed sealing methods; Duct tightness via rough-in or post-construction test

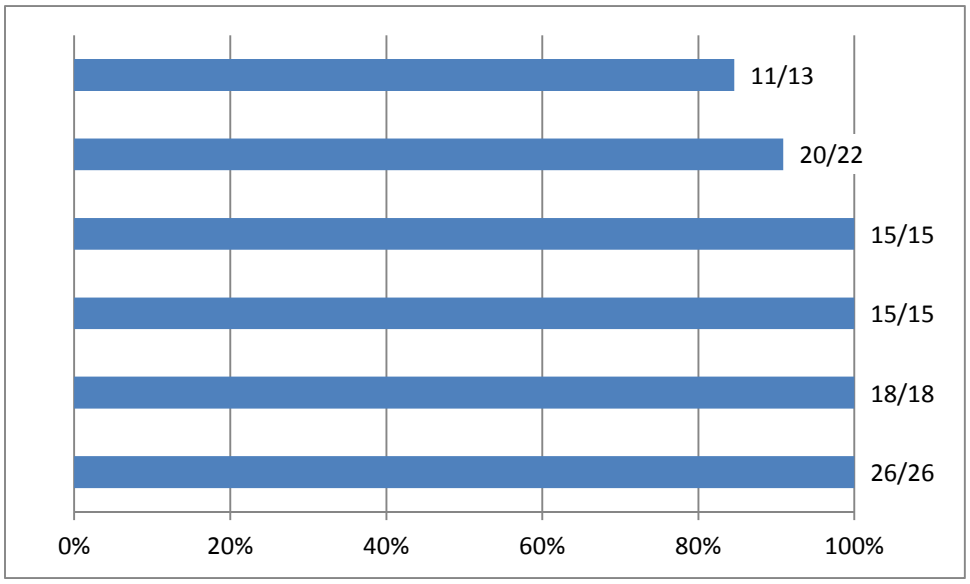

Figure 12: Jurisdiction C Pre-Training Compliance Rate per Site (6 sites)

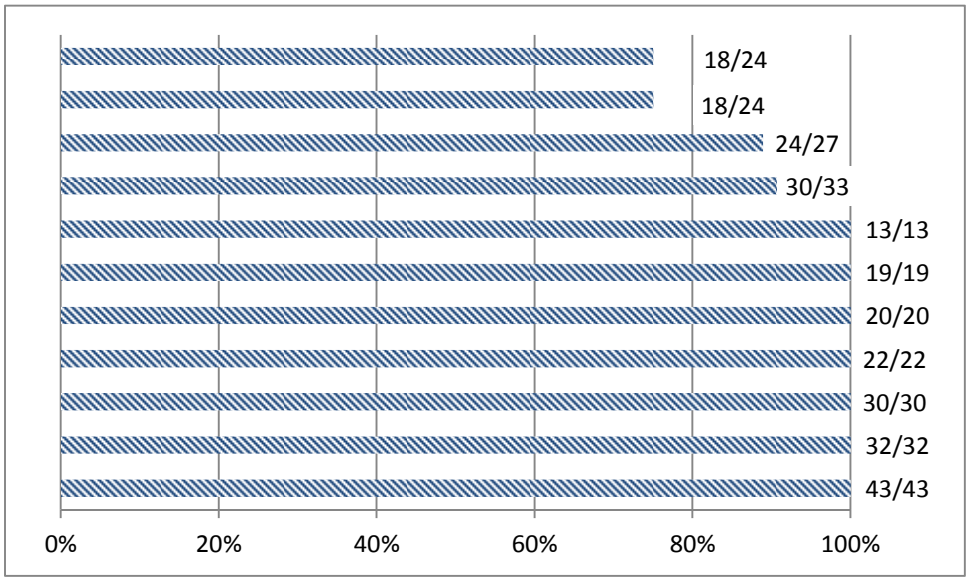

Figure 13: Jurisdiction C Post-Training Compliance Rate (11 sites)

Overall, the six projects included in the Jurisdiction C pre-training sample have a weighted overall compliance rate of 96.3%, with four of the six (80%) showing 100% compliance. The most commonly observed items amongst all of the pre-training sites were:

- Duct insulation values
- HVAC piping insulation value
- Whether the supply ducts were located in building cavities or not
- Insulation and glazing U-factors were also commonly observed

The measures with the highest rates of compliance are:

- HVAC piping insulation values
- Manufacturer manuals are provided for mechanical and water heating equipment
- Supply duct insulation values

The measures which display the lowest rates of compliance are:

- Heating and cooling equipment being sized per ACCA Manual S based on ACCA Manual J loads
- Posting of the compliance certificate.

The eleven (11) projects in the Jurisdiction C post-training sample have a weighted average overall compliance rate of 93.7%, with seven of the eleven (64%) showing 100% compliance. The most commonly observed items amongst all of the post-training sites were:

- Glazing U-factors (area-weighted average).
- Glazing SHGC value (area-weighted average)
- Wall (wood) and Ceiling (wood) insulation R-values

The measures with the higest rates of compliance are:

- Glazing U-factors (area-weighted average).
- Glazing SHGC value (area-weighted average)
- Conditioned basement wall insulation R-value.

The measures which display the lowest rates of compliance are:

- Wall (wood) insulation R-values
- Floor insulation R-values.

Of the 11 projects included in the post-training sample, more than half provided heating and cooling equipment loads based on Manual J at the time of plan review. However, we were unable to verify at the sites inspected that the installed equipment matched those specified in ACCA Manual S based on the correctly calculated loads from ACCA Manual J.

Insulation and glazing values were generally observable and in compliance for both the pre-training and post-training sites. The post-training sites display much higher observances of the different types of insulation relative to the number of sites, but also show more incidences of non-compliant insulation R-values. These measures are commonly traded off under the performance compliance approach which may explain this result. In comparison, the envelope insulation and glazing U-factor requirements were only able to be verified as compliant at two sites each in the pre-training inspections. Duct sealing and verification of HVAC equipment were not usually observable in either set, and building characteristics that can be seen at a final inspection were more commonly provided for the pre-training sites. Other than the measures identified, the pre-training and post-training sites did not share many of the same observed measures.

The results for Jurisdiction C exemplify the challenges of this pilot evaluation. Perhaps more importantly than the sample size of the pre- and post-training samples, is the focus of which measures were evaluated as part of that sample. Construction drawings and documentation are required to demonstrate energy code compliance; however these documents were unavailable or insufficient for the majority of the sites in both samples. None of the pre-training projects were able to fully review the documentation as required, and only two of the 11 post-training sites provided the required documentation, complying with the requirements. Additionally, the field inspections were unable to verify that the heating and cooling equipment installed was based on correctly calculated loads from Manual J. Heating equipment was only verified on site at two out of the six pre-training sites, versus eight of the 11 post-training sites. However, none of the on-site equipment correctly matched the capacities provided at the plan review based on Manual J loads and correlating Manual S specifications. This implies that equipment sizing and documentation of load calculations is an issue that still needs to be addressed at this jurisdiction. However, because the BECP protocol does not penalize projects for having specific information unavailable, the absence of data from the pre-training sample appears to have artificially boosted the compliance rates for Jurisdiction C during that timeframe.

Due to the slight difference in the overall compliance rate between the pre- and post-training sites, differences in measures observed, and relatively small sample sizes, it is difficult to draw a conclusive result of the trainings for Jurisdiction C. The training for Jurisdiction C plan

reviewers focused on proper use of Manual J to conduct load calculations, and the importance of consistent inputs among the various pieces of documentation (plans, Manual J documents, and REM/Rate or HERS reports). The sampling approach using the BECP Residential compliance checklist did not appear to adequately capture the information necessary to quantify a change in compliance related to the use of Manual J for HVAC load calculations.

5.5 Potential Energy Savings

The most accurate methodology to estimate energy savings would involve building a model of a single family building using the weighted average input values from the pre-training survey and compare the energy use with a model of the same prototype using the values from the post-training survey of projects. The savings between these two scenarios could then be scaled up to reflect the level of construction activity.

An alternative approach is to assume the whole-building compliance rate serves as a reasonable proxy for the percent of total energy savings being realized via energy code compliance. Values of energy savings associated with the IECC can be obtained from the BECP report: Colorado Energy and Cost Savings for New Single- and Multifamily homes: 2009 and 2012 IECC as compared to the 2006 IECC.[6] The report also summarizes the major requirement differences between the versions of code.

According to the report for Colorado, residential buildings built to the 2009 IECC save 9.3 percent of energy costs compared to those built to the 2006 IECC[7]. This equates to savings of approximately 394 kWh and 105 therms per house per year. For example, if we interpret the compliance rates calculated above to represent the percent of savings being realized, and that non-compliant values are 2006 IECC values; then the 5.8% increase in the overall compliance rate in Jurisdiction B produces savings of approximately 22.9 kWh and 6.1 therms per house per year. The estimate of annual energy savings per home for Jurisdictions A, B, and C is presented below in Figure 14.

[6] http://www.energycodes.gov/sites/default/files/documents/ColoradoResidentialCostEffectiveness.pdf

[7] These values are based on the average results for a 2,400 sq. ft house and 1,200 sq. ft apartment/condo. This provides a rather conservative estimate of savings, as most of the homes sampled were much larger than 2,400 sq. ft. The report does not include any information about demand savings (kW).

Jurisdiction	A	B	C
Compliance delta	4.8%	5.8%	-2.6%
Savings (kWh)	18.9	22.9	(10.3)
Savings (Therms)	5.0	6.1	(2.7)

Figure 14: Estimated Energy Savings per Single family house per Jurisdiction

Since Jurisdiction C was found to have a negative change in compliance rate in the data sampled, the energy impact is estimated as a negative number. We surmise that the negative change in compliance rate is likely indicative that the pre-training compliance rate was already very high (greater than 96%) based on a small sample size (six sites) where non-compliant measures were unable to be observed, therefore boosting the compliance rate as compared to the post-training sample. As discussed in Section 5.4, the measures that were evaluated during the pre-training sample seem to have missed the topics that were of the greatest need for improvement in Jurisdiction C. More of these measures were able to be observed during the post-training sample, with mixed results, producing a negative delta in the calculated overall compliance rate.

6. CONCLUSIONS & RECOMMENDATIONS

The evaluation intended to answer several questions in order for Xcel to determine whether a broader program was warranted. Based on our analysis of the data available, we provide the following responses:

- *Will a tailored approach to code training and technical support help jurisdictions adopt new energy codes? Can we quantify additional energy savings?*
  - While this evaluation did not ultimately address this question directly, we believe that training and technical support to the jurisdictions does help them better understand the code requirements and therefore better able to assess the implications of increasing the code stringency by adopting a newer energy code.
  - The savings for this activity would be relatively easy to quantify directly from the differences between the two versions of the code, as we have done for this evaluation.
- *Will a tailored approach to code training and technical support help improve and accelerate code compliance? Can we quantify additional energy savings?*
  - Yes, we conclude that the tailored training and technical support to the jurisdictions helped them better understand the code requirements and therefore were better able to enforce the code.
  - We have provided a rough estimate of energy savings attributable to the training efforts.
- *Can the DOE Building Energy Codes Program (BECP) protocol be used cost-effectively to evaluate the Code Support pilot?*
  - There are two important elements of evaluating the Code Support pilot. The first entails evaluating changes in code compliance, for which the BECP protocol can appropriately be used, with the caveats discussed in this report. In order for the BECP protocol to be most effective, since it does not penalize projects for not having the documentation available, all necessary documentation must be available and reviewed consistently throughout the process. The compliance calculation relies of detailed and consistent compliance documentation, including HVAC load calculations and equipment sizing documentation.
  - The other element requires evaluating energy savings based on the compliance improvement; which the BECP protocol is ill-suited to do on its own. Additional research is needed to develop an appropriate weighting formula that would allow for compliance rates to directly inform energy savings estimates. However it is not clear whether this would be more valuable than developing prototype energy models based on standard construction practices identified as part of a compliance assessment.
  - While we have not discussed the exact definition of cost-effective with Xcel, we think the approach followed for this evaluation was a reasonable use of the BECP protocol. The BECP protocol calls for a self-assessment of baseline compliance, which would certainly reduce the cost of data collection for evaluating a larger code support program. However, the self-reported baseline compliance data may not be consistent with the third party evaluation data, complicating the evaluation of the program

impacts. Relying on self-assessments for evaluation would further reduce costs, but may raise questions about the objectivity and reliability of the data.

- *Can we attribute savings to this pilot?*
  - While quantification of the savings from the improvements in code compliance are possible, we do not believe that savings can be attributed to this pilot for reasons documented throughout the report. The explicit link between the improvements in compliance and the training provided is not possible based on the data collected. We reach this conclusion primarily because, as stated above, the training pilot actually needed to provide fundamental review and consistency training that is a pre-cursor to actual improved compliance and verification. Continued training of these and other jurisdictions will allow for improved compliance and proper documentation that will allow for better compliance verification. Additionally, the condensed timeframe of the pilot did not allow for sufficient time to evaluate projects that were constructed based on plans that had been reviewed after the plan reviewers received training. Furthermore, competing trainings provided by CCC under contracts with the State or entities other than Xcel were not fully vetted during the evaluation, which would affect the attribution of savings.
- *What are the potential and achievable savings for the pilot jurisdictions?*
  - Although there may not be savings directly attributable to this pilot, we have estimated potential energy savings, based on the change in code compliance found in this pilot. The results are provided in Section 1.3.

6.1 Compliance Rates and Potential Energy Savings

The compliance rates with the 2009 IECC presented in Figure 15 are based on the measures that were observable at the time the data were collected. Due to the small sample sizes, the statistical confidence of the compliance rates being reported is very low. Additionally, the compliance rates being reported are relatively high, ranging from 87.0% to 96.3%. Measures that are not available for observation are not considered in the calculation of the overall compliance rate, and therefore do not improve or penalize the compliance score. Additionally, the relatively high compliance rates are based on relatively few samples, which may not necessarily be representative of general practices in each jurisdiction.

Jurisdiction	Pre-Training		Post-Training	
	Number of Sites	Weighted Overall Compliance Rate	Number of Sites	Weighted Overall Compliance Rate
Jurisdiction A	13	90.5%	13	95.3%
Jurisdiction B	13	87.0%	9	92.8%
Jurisdiction C	6	96.3%	11	93.7%

Figure 15: Summary of Weighted Overall Compliance Rates pre- and post-training

Figure 16 provides the estimated annual energy savings per single family house in each jurisdiction based on the change in compliance. We calculated the approximate energy savings based on the change in overall compliance rates (Figure 15), assuming that non-compliant measures met the 2006 IECC instead of the 2009 requirements. The methodology for this savings estimation is described in greater detail in Section 5.5.

Jurisdiction	A	B	C
Compliance delta	4.8%	5.80%	-2.6%
Savings (kWh)	18.9	22.9	(10.3)
Savings (Therms)	5.0	6.1	(2.7)

Figure 16: Estimated Annual Energy Savings per single family house per Jurisdiction

According to the BECP report: Colorado Energy and Cost Savings for New Single- and Multifamily homes: 2009 and 2012 IECC as compared to the 2006 IECC, residential buildings built to the 2009 IECC save 9.3 percent of energy costs compared to those built to the 2006 IECC[8]. This equates to savings of approximately 394 kWh and 105 therms per house per year.

[8] These values are based on the average results for a 2,400 sq. ft house and 1,200 sq. ft apartment/condo. This provides a rather conservative estimate of savings, as most of the homes sampled were much larger than 2,400 sq. ft. Information regarding demand savings (kW) was unavailable as part of this report. The full report is available at: http://www.energycodes.gov/sites/default/files/documents/ColoradoResidentialCostEffectiveness.pdf

Since Jurisdiction C was found to have a negative change in compliance rate (i.e. the compliance rate decreased after training), the energy impact is estimated as a negative number. However, we surmise that the negative change in compliance rate is likely indicative that the pre-training compliance rate was already very high (greater than 96%) based on a small sample size (six sites) where non-compliant measures were unable to be observed, therefore boosting the compliance rate as compared to the post-training sample. Further discussion of this result is provided in Section 5.4.

6.2 Training Assessment Conclusions

There is a need for on-going and sustained training opportunities with the plan review process. Training and education are needed to increase core knowledge of specific items, such as use of proper climate data and how to review Manual J. Increased understanding of code, ACCA Manuals J, S and D, and energy documents will improve the confidence, speed and efficiency of plan reviewers.

Currently there is not enough consistent data through design and construction to determine with any confidence that the equipment size is 1) based on the load calculations or 2) would result in reduced equipment sizing even if the load calculations were followed. Currently, the industry uses standard rules of thumb for equipment sizing and oversizing safety factors. These practices are very slow to change. Understanding and enforcement of the code requirements by the building department staff is the first step in the long process of changing current rule of thumb practice to better designed systems.

If designers and contractors perform Manual J load calculations, Manual S equipment selection and Manual D duct sizing according to actual building components and conditions, then the resulting installed system would be properly sized for the building. As building envelope requirements are tightened over time, based on code requirements or current practice, the resulting loads and equipment specifications would decrease.

There is also a general lack of field knowledge of energy code requirements. Field inspections tend to rely on the HERS rater for the energy code elements of the inspection, while some mandatory elements of the code are not checked or used by raters to calculate the HERS score. There is an opportunity to provide additional field training. Improved field knowledge will result in better understanding of energy compliance documentation and the approval process. Educating the inspectors so that during their inspections they can provide education to the contractors would also be very beneficial.

While the evaluation results are inconclusive as to whether additional energy savings can be achieved, our follow up conversations with trained building department staff suggests that better training of staff will result in more confidence, allowing them to request additional information from builders. Once builders know that the building departments are requiring complete energy compliance submittals and they understand those requirements, they will submit complete and consistent documentation. These two inter-related efforts will produce better overall code compliance.

During the training, the HERS raters said that some jurisdictions hold preconstruction meetings for each project, where they have someone from the different trades present to walk through the project and inspection process prior to issuing a permit. This can help contractors learn the

requirements of the other trades, which can go a long way toward consistent, compliant submittals.

While the training and results of this pilot ended up focused exclusively on the residential sector, similar efforts are needed for the commercial sector. Commercial energy code trainings were ultimately dropped from the training plan for each jurisdiction for multiple reasons, including few commercial projects, lack of time to see results of training in the field (due to longer construction timelines for commercial projects than residential buildings) as well as a greater reluctance by building departments to explore deficiencies in commercial code compliance. Building departments are generally aware of the areas of the residential energy code requiring additional focus, whereas knowledge of the commercial energy code is generally much more limited, with a greater reliance on the professional engineers and architects involved in design and construction to understand and comply with the commercial energy code. Further information is needed to assess whether the energy code requirements are being met through this approach. Based on our assessment of the residential energy code compliance issues we strongly believe that increased knowledge of the commercial code requirements will allow the plan reviewers and inspectors to better ensure compliance with the code.

6.3 Recommendations

Based on our evaluation efforts, we have the following observations and recommendations for a continued and expanded code support program.

New Construction programs are justified on improvements over baselines, and changes to code impact this baseline. Advancements in codes can impact the ability of traditional utility incentive programs to encourage advanced design. However, tension can be reduced through integrated program activities involving both new construction and code support. With any adoption of more stringent codes, outreach efforts are needed to support implementation. By developing a new program theory and implementation approach, both kinds of programs can be more effective, and the full measure of savings can be captured by the utility.

The type of outreach that accompanies a traditional new construction program is fundamentally similar to the portion of a code support program targeting the design community. Additional training for the building department staff differentiates the scope of the code support program, but evaluation of energy savings would rely on the compliance rates in the field. Field inspection of energy code compliance is already required for participation in new construction incentive programs, and expanding that evaluation effort to include measures covered by the code training would be a cost-effective method of collecting the data necessary to support claiming energy savings for the code support initiative.

This approach is being investigated by utilities in other states. HMG is currently working with statewide utility groups in California and Massachusetts to pursue this program structures. By coordinating early with regulators, utilities can establish a pre-program agreement that will allow them to claim the energy savings from code compliance improvement.

Code support programs generally require more time to collect sufficient data to estimate program impacts at a statistically significant level than most utility-funded energy efficiency incentive programs. Additionally, the cost of conducting these evaluations can be cost prohibitive unless there are other programs requiring the same data that can share some of the burden of data

collection. The type of projects being targeted and measured as part of existing New Construction programs can overlap very nicely with projects that would be targeted and measured as part of a code support program. However savings would be attributable to the code support activities for all new construction, not just projects enrolled in the program.

Coordination of new initiatives with existing programs will also identify opportunities to leverage existing, established resources (e.g., special funds, education strategies, and marketing assets such as existing websites). Specifically, strategic coordination with active professional groups (such as SWEEP), state agencies (such as the Colorado Energy Office), and local code officials will improve best practices training of the building design community to meet and exceed minimum energy code requirements.

Feedback from CCC indicates that free training is insufficient on its own to attract more participation from building jurisdictions. Providing tools to the building departments to help with compliance/enforcement would help encourage greater participation and differentiate this program from other code resources, making it easier to track attribution of savings to the program. The trainings need to focus on how to incorporate energy code inspections into what is already being done, not just teaching what the code requires. Emphasis on how the inspectors and reviewers can do their job with the staff and resources they have available is valuable to the building department staff and will produce a larger impact trainings that only focus on content.

Attribution could be clearer if Xcel were the only provider of code-related trainings in their territory. This would only be possible if Xcel were able to work out an agreement with the state and other potential training supporters. If this is not possible or desired, Xcel could differentiate their program offerings as trialed by this pilot and recommended in this report. Tailoring the training to meet the needs of the individual jurisdictions and providing tools to help with compliance/enforcement would help attract participation and make it easier to track attribution of savings to the program.

7. APPENDIX A: TRAINING PLANS

7.1 Common training

7.1.1 Staff Training

Load Calculations

- Manual J – Load Calculations
- Manual D – Duct Design
- Duct Testing
- Manual S – equipment sizing

Coordinate Code Submittal Documentation: Manual J, ResCheck and HERS reports

- Inspection checklists

Commercial Energy Compliance- Thermal Envelope, Mechanical, Lighting

- Commercial Envelope
- Residential Thermal Envelope
- Energy Code Certification Training
  - Differences between 2009/2012 IECC: 2012 IECC training for 2013 adoption

7.1.2 Training with Community, Designers and Builders

- Coordinate Code Submittal Documentation: Manual J, ResCheck and HERS
  - How to submit documents correctly to reduce review time
  - How to coordinate plans with energy compliance documentation
  - House as a System
  - Thermal Envelope
  - Equipment Load Calculations
  - Manual D- Duct Design
  - Air Sealing
  - Commercial Lighting requirements
- Commercial equipment sizing
  - Building thermal envelope requirements (both commercial and residential)
  - Ventilation strategies
  - IECC training: Difference between 2009 and 2012 IECC

7.2 Jurisdiction A

Jurisdiction A will start with community training and work staff training in during a slower time, perhaps fall. Will also check with local HERS raters to see which other trainings will be beneficial as they do a lot of the residential energy inspections and will have a better idea of the needs.

- Training with Community, Designers and Builders
  - House as a System
  - Building thermal envelope requirements (both commercial and residential)
  - Equipment Load Calculations
  - Manual D- Duct Design
  - Air Sealing
  - Commercial Lighting requirements
  - Energy Code Submittal Documentation (how to coordinate the various submittals like load calcs, ResCheck/ Com Check or HERS reports with the plans to make sure they all agree)
  - Xcel programs
- Staff Training
  - Load Calculations
  - Commercial Envelope
  - Energy Code Certification Training

7.3 Jurisdiction B

Training for the two plan reviewers – one is too slow (is not confident in what she knows), one is too detailed (takes too long). Eventually incorporate training on 2012 IECC that will be adopted late 2013.

- One on One training with Barb Kuettel, Residential Plan Reviewer
  - Thermal Envelope
  - Manual J – Load Calculations
  - Manual D – Duct Design
  - Energy Code Submittal Documentation (how to coordinate the various submittals like Manual J, ResCheck or HERS reports to make sure they all agree)
- One on One training with Robert Skinner, Residential and Commercial Plan Reviewer
  - Manual D- Duct Design
  - Duct Testing
  - A more efficient review time without losing energy efficiency

- Commercial Energy Compliance- Thermal Envelope, Mechanical, Lighting

- Building Inspection Staff
  - May include some onsite training while doing volunteer baslining
- Designers, Contractors, Building Owners
  - Mechanical Contractors trained on Jurisdiction B specific requirements and climate data
  - How to submit documents correctly to reduce review time and kickbacks of plan reviews.
  - How to coordinate plans with energy compliance documentation
  - Commercial equipment sizing
  - Thermal Envelope
  - House as a system
  - Xcel programs- education on what is available
  - Ventilation strategies

7.4 Jurisdiction C

Jurisdiction C staff training would have to be doubled up so that half of the staff could attend one day and the rest another day. Training for the 2012 would be in the last quarter of 2012 for staff and in first quarter of 2013 for designers and contractors. Jurisdiction C interested in learning any amendments that may be needed for the 2012 IECC adoption.

- Training with Community, Designers and Builders
  - IECC training to assist closing the gap between what is submitted and what would meet code compliance.
  - Difference between 2009 and 2012 IECC
  - Equipment Load Calculations
  - Manual D- Duct Design
  - Energy Code Submittal Documentation (how to coordinate the various submittals like load calcs, ResCheck/ Com Check or HERS reports with the plans to make sure they all agree)
  - Xcel programs
- Staff Training
  - Load Calculations and Manual S
  - Duct testing
  - ASHRAE 90.1
  - Inspection checklists

- Differences between 2009/2012 IECC
- 2012 IECC training for 2013 adoption

7.5 Jurisdiction D

Jurisdiction D would like their Building, Mechanical and Electrical Inspectors certified by ICC as Energy Code Inspectors. This is the only training that they are agreeing to at this time.

The training plan will be to teach six - 1.5 hour classes each week (twice a week so that half of the staff can attend one day and half the other) on different sections of the code. Because this isn't really a lot of time to get the code taught enough for full understanding in order to pass an exam, I will create handouts and homework for the students to take home and we will go over it in class. I will create practice exams framed on getting them looking through the code and familiar with where to find answers to energy code questions in the code book.

An opportunity still exists to measure where the inspectors are at while teaching. We can then come back later and measure what differences were made in their inspection process as a result of their education.

7.6 Jurisdiction E

- Training with Building Official/Plan Reviewer and other office staff
  - Significant Changes from 2006 to 2009 (to help with adoption process mainly)
  - Building thermal envelope requirements (both commercial and residential)
  - Equipment Load Calculations (simplified)
  - Manual D- Duct Design
  - ComCheck/ResCheck training
  - Commercial Lighting requirements
  - Energy Code Submittal Documentation (how to coordinate the various submittals like load calcs, ResCheck/ Com Check or HERS reports to make sure they all agree)
- Inspector Training
  - Insulation Installation
  - Commercial Lighting Inspections
  - Air Barrier Inspections
  - Window Inspections
- Designers, Contractors, Building Owners
  - Mechanical Contractors on load calculations
  - Significant Changes from 2006 to 2009
  - How to coordinate plans with energy compliance documentation
  - Xcel programs- education on what is available

After basic training of code officials in Jurisdiction E on the significant changes, we will determine which portions of the code they will incorporate into their processes and come up with an implementation plan for compliances as well as training, which will be shared with the designers and builders.

7.7 Jurisdiction F

The Chief Building Official for Jurisdiction F, is concerned about the amount of work her staff is having to do each day and does not believe that they have time to be a part of this Xcel study with the exception of assistance with which code to adopt in the future.

Jurisdiction F was thinking of adopting the 2012 codes but is quite concerned over the Energy Code adoption and was not sure that it was the right code to adopt. The Chief Building Official is concerned about how fast the energy code is moving and how much change there is in every cycle. Instead of just updating the code they rewrite it each time and it is going too far for code officials to enforce.

The Chief Building Official agreed to allow CCC to come in and talk to her and her staff about the 2009 IECC, 2012 IECC and what could be coming in the 2015. CCC would educate them on all 3 of the codes and they would then make an educated decision on which code to adopt in the future. The Chief Building Official noted that they were likely to just stay on the 2009 unless we helped them find a way to move forward.

The opportunity still exists here to measure where they are at and educate them on energy codes while helping them with future adoption. Also, Jurisdiction F was adamant that Xcel be allowed to take credit for any adoption of a more current code because they really don't expect to movie forward right now, but are willing to listen to what CCC has to say.

Suggest meetings with the Chief Building Official and key staff to discuss what they are doing with the 2009 and what is involved in the 2012 to see if there is an implementation or education plan that could get them moving forward.

8. APPENDIX B: EVALUATION PLANS

8.1 Evaluation Outline – Jurisdiction A

Moved to IECC 2009 in Nov, 2011.

Approve Xcel training plan and evaluation plan by July 17th.

Most commercial work is retrofit. This pilot program is for new construction, but we can use this evaluation to prove the theory that improved compliance will improve energy savings in actual bldgs.

8.1.1 Xcel Support

Need training for residential and commercial builders, designers, and contractors with the goal of receiving better plans with less resubmittals.

Identified issues: Manuals J and D, mechanical, thermal envelope, systems approach, retrofits, small commercial builders. Manual D. Duct Design – Design community training first, then staff in the fall. (This pilot is not supposed to cover retrofits, but can use them for evaluation purposes).

Commercial inspections are difficult. Training may be helpful.

8.1.2 Evaluation

- Manuals J and D – Currently not receiving correct submittals, consistently rejecting them. The theory is that improving the review process (reducing number of resubmittals) will increase the ability to focus on the energy code.
  - Pre-training - Shaunna to perform plan reviews and field inspections to identify level of understanding, review Manual J load calcs to see if they are being performed properly and to obtain baseline information, to record what was specified, what was installed, and what should have been installed. Baseline from plan review and site visits used to focus training.
  - Shaunna will perform a Manual J calculation based on plan submittals to see what should have been installed, difference between right-sized and installed equipment (on a BTU/sf basis to normalize).
  - Baseline first – review the plans, look on site. Determining whether it is being done correctly, even if staff doesn't understand. Training on problem areas identified during plan review; train design community first. Train building staff in the fall. Focus on inspections to verify equipment matches plans.
  - Train staff on how to do a streamlined version of the Manual J, verify the equipment on the plans is properly sized, verify equipment that is installed. Shaunna will provide the streamlined Manual J calculation to Xcel Energy and HMG.

- Post training – Plan reviews for info to calculate Manual J right-size, verify equipment size specified on plans. Field inspection to verify properly sized equipment is installed.
- Manual D. Duct Design – similar process of pre and post training inspection.
- Energy savings will be on a per-house basis, but can be normalized using BTU/sf based on over-sizing vs right-sizing of equipment and ducts to estimate total energy savings. Min of 3 homes pre and 3 home post.

- Duct Blaster and Blower Door Tests – Only applicable for 10% of homes that use prescriptive method because HERS raters take care of this in the performance path.
  - Baseline – Shaunna to review plans for homes specifically identified as conducting blower door tests or using the inspection checklist; include ducts not in conditioned space. On-site inspection is preferred, if not possible then a review of the inspection notes will have to suffice, see what was verified.
  - This may be a several step process, Shaunna will need to figure out what needs to be done, based on what is submitted. If she can't go on site, she will go through the inspection notes – check what they verified. That is the best we can do. But since they have a lot of construction, we should be able to find some projects to go on site.
  - For other 90% of homes using performance method of compliance (and presumably doing a good job because of HERS inspections) baseline to use as example/show potential savings for other jurisdictions.
  - Training on problem areas identified in baseline review.
  - Post-training - on-site inspections at time of test, or review of inspection notes.
  - Energy savings will be on a per home basis, perhaps normalized to a sq. ft. basis to allow for extrapolation beyond the sample size.
  - Use these results to determine potential savings in other jurisdictions.
- Residential inspections – Reliance on HERS ratings implies trust that HERS raters are doing a good job. Xcel/CCC can talk to HERS raters as to where there needs to be more training. This is builder community assistance not code official assistance.
  - Baseline – focus on field visits to homes using the performance path. Meet with HERS raters to get their perspective on issues in the field, assess their work.
  - Training – for residential inspectors or HERS raters as desired.
  - Post-training inspection at those homes using performance path. Installation inspection – it needs to be done correctly for code (level 1), need to do insulation installation correctly, at a minimum. The County is expecting the HERS raters to check for this.
  - Baseline: Insulation inspection – are they doing it right? if so, we won't do anything, and won't find any savings.
  - There may not be any energy savings if it ultimately gets done correctly. CCC may do a few HERS scores to see if HERS raters are doing it right. [Shaunna please confirm.]

- Energy Savings from inspections – Only will achieve savings if the HERS inspections were found to be lacking.

- Commercial inspections. CCC needs to talk to the County on what they are currently doing. Training on specific inspections may be helpful. Perhaps look at envelope issues.
  - Baseline: look at plans, verify plan inspection is correct, and conduct field inspection to see that correct products (envelope) and equipment (mechanical and lighting) are being installed.
  - Post-training review and inspection approach would be the same as for baseline.
  - Saving would come from improvement in installation as per code requirements.

8.2 Evaluation Outline – Jurisdiction B

Moved to 2009 IECC in March 2011

Three (3) year cycle for code update; IECC 2012 by mid-2013

50% of new residential are Energy Star, using code performance method.

Approved Xcel training plan and evaluation plan by July 17th

8.2.1 Xcel Support

Training for code staff (2) and building and design community, residential is the priority. There may be a gap between strategies/intent of plan reviewers and inspectors. Focus on Manuals J and D, perhaps also train commercial contractors; design calculations can be up to 40% above design loads.

8.2.2 Evaluation

- Train Residential plan review staff – Barb is new, helping her get up to speed will increase compliance rates in the jurisdiction, and allow Robert to help out on Commercial.
  - Baseline for residential code assessed by CCC at beginning of training for plan reviews. Also some field visits to see if inspectors are following up on plan review feedback. CCC to review a minimum of 3 projects.
  - Train plan reviewer on Residential code during baseline development.
  - Train plan reviewer on commercial code, reduce level of scrutiny on his residential reviews.
  - Post training plan reviews and inspections (min. of 3 res. projects). Collect information on what is installed (final inspection).
  - Energy savings based on differences identified between pre and post plan reviews and inspections.
- Training designers and mechanical contractors - Mechanical contractors have a hard time presenting their plans – need training. Jurisdiction B provides parameters – designers do not read them.

- Baseline plans and inspections, especially equipment sizing, coordination of documents being submitted, thermal envelope tightness, and relationship between plan reviews and inspections. HMG to attend some of the inspections.
- Training for designers and contractors, possibly also for inspectors.
- Post-training look for coordinated submittal documents, verify installations match plans and comply with code.
- Energy Savings from increased compliance with code, proper calculations of design load.

- Need to find out what types (and quantity) of commercial buildings available or baseline
  - Multifamily and hotels may be a good opportunity for commercial baseline based on plan review (applicable for other jurisdictions as well).

8.3 Evaluation Outline – Jurisdiction C

Moving to IECC 2012 in June/July 2013

4Q 2012 – Chief Building Official and staff review IECC 2012, start training code staff on IECC 2012

1Q 2013 - Training for Builders and Designers – CCC training

Most residential builders are doing a good job with IECC 2009; no real needs for training.

Inspectors rely on 3rd party HERS raters for residential inspections. No additional checking by code officials.

Using Manual J & D now; good skill levels. Need Manual S training for IECC 2012.

Jurisdiction C interested in learning any amendments that may be needed for 2012 IECC adoption.

8.3.1 Xcel Support

1. Training with Community, Designers and Builders
   A. IECC training to assist closing the gap between what is submitted and what would meet code compliance.
   B. Difference between 2009 and 2012 IECC
   C. Equipment Load Calculations
   D. Manual D- Duct Design
   E. Energy Code Submittal Documentation (how to coordinate the various submittals like load calcs, ResCheck/ Com Check or HERS reports with the plans to make sure they all agree)
   F. Xcel programs
2. Staff Training
   A. Load Calculations and Manual S
   B. Duct testing

C. ASHRAE 90.1
D. Inspection checklists
E. Differences between 2009/2012 IECC
F. 2012 IECC training for 2013 adoption

8.3.2 Evaluation

- Baseline needs to be developed for 2009 IECC
  - Assess what is being submitted
  - Review current approach to load calculations and Manual S (compare to ideal approach) and verify how equipment installed relates to load sizing calcs being performed (some onsite visits ideal, at least some plan review.
    - Training on problem areas identified in baseline review.
    - Post-training - on-site inspections at time of test, or review of inspection notes.
    - Energy savings will be on a per home basis, perhaps normalized to a sq. ft. basis to allow for extrapolation beyond the sample size.
    - Use these results to determine potential savings in other jurisdictions.
- Duct Testing Baseline
  - Shaunna to review plans for homes specifically identified as conducting duct testing or using the inspection checklist; include ducts not in conditioned space. On-site inspection is preferred, if not possible then a review of the inspection notes will have to suffice, see what was verified.
  - This may be a several step process, Shaunna will need to figure out what needs to be done, based on what is submitted. If she can't go on site, she will go through the inspection notes – check what was verified.
  - Training on problem areas identified in baseline review.
  - Post-training - on-site inspections at time of test, or review of inspection notes.
  - Energy savings will be on a per home basis, perhaps normalized to a sq. ft. basis to allow for extrapolation beyond the sample size.
- 2012 IECC
  - Identify amendments to 2012 IECC being considered (either increasing or reducing stringency of code requirements)
  - Compare to amendments finally adopted next year after training of code staff and design/building community

8.4 Evaluation Outline – Jurisdiction D – not developed

8.5 Evaluation Outline – Jurisdiction E

Current Code: IECC 2006

Moving to IECC 2009 or 2012. Adopt in March 2013 – in effect July 2013.

Approved Xcel training plan and evaluation plan by Dec 10, 2012.

8.5.1 Xcel Support

Want support to make the move from IECC 06 to 2009 or 2012. Hopefully adoption process will be in February/March of 2013.

New Building Official should start after the first of the year so some of the adoption decisions as well as full training decisions may change based on what the new person may want to do but the County agrees to move forward with a tentative adoption and training plan.

Want building staff training on significant changes to the code prior to deciding how to adopt and what amendments they will make and policies they will create.

Want building staff trained before code goes into effect (ideally between March 2013 and June 2013)

Training:

- Early training for staff on 2006 to 2009 IECC significant changes
- Training for staff, designers and contractors on full IECC, including how to submit and review energy documentation.
- Additional specific training, see below

8.5.2 Evaluation

Training on changes for 2009 will help them adopt entire 2009 code. Xcel can take credit for this as part of moving to 2009, part of the proof of influence and support. Additional trainings will help them increase compliance with 2006 code and better prepare for 2009 code. Without Xcel helping with their process of moving up to more stringent code, it is unlikely that savings would occur, or code could even be fully enforced. Need to document interactions showing this to be true.

- Insulation inspection – training will improve R-values and quality of installation.
  - Baseline pre training – plan check and field inspect what is current practice; look at both R-value and quality of installation.
  - Provide training on how to inspect R-value and assess installation quality.
  - Post training – Field inspections on R-values and quality of installation again, ideally at least 3 homes complying under prescriptive method and 3 using performance method. Post-inspection is contingent upon baseline showing room for improvement, and potential savings. If the installation is already correct (pre-training) then there is no improvement.

- Manual J load calculations – currently not required nor being checked. The County needs to review and correct the sizing being submitted to convince contractors to do it properly.
  - Pre-training - Shaunna to perform plan reviews and field inspections to obtain baseline information, to record what was specified, what was installed, and what should have been installed.
    - Shaunna will perform a Manual J calculation based on plan submittals to see what should have been installed, difference between right-sized and installed equipment (on a BTU/sf basis to normalize).
  - Train staff on how to do a streamlined version of the Manual J, verify the equipment on the plans is properly sized, verify equipment that is installed. Also train contractors on requirements. Shaunna will provide the streamlined Manual J calculation to Xcel Energy and HMG.
  - Post training – Plan reviews for info to calculate Manual J right-size, verify equipment size specified on plans. Field inspection to verify properly sized equipment is installed.
  - Energy savings will be on a per-house basis, but can be normalized using BTU/sf based on over-sizing vs right-sizing to estimate total energy savings. Min of 3 homes pre and 3 home post.
- Electrical inspections – low priority, focus on commercial interior lighting.
  - Pre- training – perform plan review to identify LPD planned vs allowed, verify controls are being assigned where required, compare plans to code requirements, verify installation in field compared to design.
  - Training on reviewing LPD calculations, simplified version, and ComCheck – how it is done, what to look for, and teach about controls
  - Post-training - Plan review for lighting layout and LPD, verify installation in field depending on what is found.
  - Energy savings will be determined by the difference between pre-training and post-training LPDs and installation of controls. Ideally we should look at 3 projects pre and 3 projects post. Post-training may be limited if no commercial permits. For evaluation purposes we can review lighting retrofit projects.

8.6 Evaluation Outline – Jurisdiction F – not developed

9. APPENDIX C: DATA COLLECTION FORMS

The DOE Building Energy Codes Program has developed standard compliance checklists for conducting building evaluations based on a review of the plans and actual construction in the field. Additionally, the Score + Store™ tool is available to aid states and local jurisdictions in storing building sample data gathered as part of a compliance evaluation. The tool automates the reporting process, helping to align data gathered across the jurisdictions. In the field, it is extremely rare that one project will be available for plan review and inspections at all of the right times in order to fill out every line of the checklist. Therefore, related information from similar but different buildings can be combined to create a snapshot of the building practices and energy code compliance in a particular jurisdiction over a specific time period.

9.1 Residential Data Collection Checklist, 2009 International Energy Conservation Code, Climate Zone 5 and Marine 4

Building ID:_____ Date:_____ Name of Evaluator(s):_____

Building Contact: Name:_____ Phone:_____ Email:_____

Building Name & Address:_____

Subdivision:_____ Lot #:_____ Conditioned Floor Area:_____ ft^2

State:_____ County:_____ Jurisdiction:_____

Compliance Approach (check all that apply): Prescriptive Trade-Off Performance

Compliance Software Used:_____ Green Building/Above-Code Program:_____

Building Type: 1- and 2-Family, Detached: Single Family Modular Townhouse

Multifamily: Apartment Condominium

Project Type: New Building Existing Building Addition Existing Building Renovation

IECC Section #	Pre-Inspection/Plan Review	Code Value	Verified Value	Complies				Comments/Assumptions[1]
				Y	N	N/O	N/A	
103.2 [PR1][1]	Construction drawings and documentation available. Documentation sufficiently demonstrates energy code compliance.							
403.6 [PR2][2]	HVAC loads calculations: Heating system size(s): Cooling system size(s):		kBtu: _____ kBtu: _____					

Additional Comments/Assumptions: _____

[1] Use Comments/Assumptions to document code requirements that pass due to exceptions, and specify the exception. Also use Comments/Assumptions to document multiple values observed for a given code requirement, such as multiple equipment efficiencies.

General building information only required if different than above Building ID:_____

Date:_____ Name of Evaluator(s): _____

Building Name & Address:_____ Conditioned Floor Area:_____ ft^2

Building Contact: Name:_____ Phone:_____ Email:_____

Compliance Approach (check all that apply): Prescriptive Trade-Off Performance

Compliance Software Used:_____ Green Building/Above-Code Program:_____

IECC Section #	Foundation Inspection	Code Value	Verified Value	Complies				Comments/Assumptions
				Y	N	N/O	N/A	
402.1.1 [FO1][1]	Slab edge insulation R-value.	Unheated: R-10 Heated: R-15	R-_____ Unheated Heated					
303.2, 402.2.8 [FO2][1]	Slab edge insulation installed per manufacturer's instructions.							
402.1.1 [FO3][1]	Slab edge insulation depth/length.	2 ft.	_____ ft.					
402.1.1 [FO4][1]	Basement wall exterior insulation R-value[2].	Continuous: R-10	R-_____					
303.2 [FO5][1]	Basement wall exterior insulation installed per manufacturer's instructions.							
402.2.7 [FO6][1]	Basement wall exterior insulation depth.	10 ft. or to basement floor	_____ ft.					
402.2.9 [FO7][1]	Crawl space wall insulation R-value.	Continuous: R-10 Cavity: R-13	R-_____ R-_____					
303.2 [FO8][1]	Crawl space wall insulation installed per manufacturer's instructions.							
402.2.9 [FO9][1]	Crawl space continuous vapor retarder installed with joints overlapped by 6 inches and sealed, and extending at least 6" up the stem wall.							
303.2.1 [FO10][2]	Exposed foundation insulation protection.							
403.8 [FO11][2]	Snow melt controls.							

Additional Comments/Assumptions: _____

[2] Basement insulation is not required in warm-humid locations.

General building information only required if different than above Building ID:_____

Date:_____ Name of Evaluator(s): _____

Building Name & Address:_____ Conditioned Floor Area:_____ ft^2

Building Contact: Name:_____ Phone:_____ Email:_____

Compliance Approach (check all that apply): Prescriptive Trade-Off Performance

Compliance Software Used:_____ Green Building/Above-Code Program:_____

IECC Section #	Framing / Rough-In Inspection	Code Value	Verified Value	Complies				Comments/Assumptions
				Y	N	N/O	N/A	
402.1.1, 402.3.4 [FR1][1]	Door U-factor. [3]	U-0.35	U-_____					
402.1.1, 402.3.1, 402.3.3, 402.5 [FR2][1]	Glazing U-factor (area-weighted average). [4]	U-0.35 (0.48 max)[5]	U-_____					
402.1.1, 402.3.2, 402.3.3 [FR3][1]	Glazing SHGC value, including sunrooms (area-weighted average). [4]	N/A	SHGC: _____					
303.1.3 [FR4][1]	Glazing labeled for U-factor (or default values used).							
402.1.1, 402.3.3, 402.5 [FR5][1]	Skylight U-factor. [4]	U-0.6 (0.75 max)[5]	U-_____					
402.1.1, 402.3.3 [FR6][1]	Skylight SHGC value.[4]	N/A	SHGC: _____					
303.1.3 [FR7][1]	Skylights labeled for U-factor (or default values used).							
402.3.5 [FR8][1]	Sunroom glazing U-factor.	U-0.5	U-_____					
402.3.5 [FR9][1]	Sunroom skylight U-factor.	U-0.75	U-_____					
402.1.1 [FR10][1]	Mass wall exterior insulation R-value.	R-13[6]	R-_____					
303.2 [FR11][1]	Mass wall exterior insulation installed per manufacturer's instructions.							
403.2.1 [FR12][1]	Duct insulation.	Attic Supply: R-8 Other: R-6	R-_____ R-_____					
403.2.2	Duct sealing complies with listed							

[3] One side-hinged door up to 24 ft^2 can be exempted from the prescriptive door U-factor requirements.

[4] Up to 15 ft^2 of glazed fenestration, including skylights, may be exempted from U-factor and SHGC requirements under the prescriptive approach.

[5] U-factor mandatory maximum using trade-offs.

[6] If more than ½ the insulation is on the interior, mass wall interior insulation requirement applies (R-17).

[FR13][1]	sealing methods.							
403.2.2 [FR14][1]	Duct tightness via rough-in test. If applicable, verification via post-construction test should be marked N/A.	Across System: 6 cfm No Air Handler:: 4 cfm	_____ cfm					
403.2.3 [FR15][1]	Building cavities NOT used for supply ducts.							
402.4.5 [FR16][2]	IC-rated recessed lighting fixtures meet infiltration criteria.							
403.3 [FR17][2]	HVAC piping insulation.	R-3	R-_____					
403.4 [FR18][2]	Circulating hot-water piping insulation.	R-2	R-_____					
403.5 [FR19][2]	Dampers Installed on all outdoor Intake and exhaust openings.							
402.4.4 [FR20][3]	Glazed fenestration air leakage.	0.3 cfm/ft^2	_____ cfm/ ft^2					
402.4.4 [FR21][3]	Swinging door air leakage.	0.5 cfm/ft^2	_____ cfm/ ft^2					
402.4.4 [FR22][3]	Fenestration and doors labeled for air leakage.							

Additional Comments/Assumptions: _____

General building information only required if different than above Building ID:_____

Date:_____ Name of Evaluator(s): _____

Building Name & Address:_____ Conditioned Floor Area:_____ ft^2

Building Contact: Name:_____ Phone:_____ Email:_____

Compliance Approach (check all that apply): Prescriptive Trade-Off Performance

Compliance Software Used:_____ Green Building/Above-Code Program:_____

IECC Section #	Insulation Inspection	Code Value	Verified Value	Complies				Comments/Assumptions
				Y	N	N/O	N/A	
402.1.1, 402.2.5, 402.2.6 [IN1][1]	Floor insulation R-value.	Wood: R-30[7] Steel:[8] See footnote	R-_____ Wood Steel					
303.2 [IN2][1]	Floor insulation installed per manufacturer's instructions, and in substantial contact with the subfloor.							
402.1.1 402.2.5 402.2.4 [IN3][1]	Wall insulation R-value.	Wood: R-20 or R-13+R-5 Mass:[9] R-17 Steel:[10] See footnote	R-_____ Wood Mass Steel	☐	☐	☐		
303.2 [IN4][1]	Wall insulation installed per manufacturer's instructions.			☐	☐	☐		
402.1.1 [IN5][1]	Basement wall interior insulation R-value.	Continuous: R-10 Cavity: R-13	R-_____ R-_____	☐	☐	☐		
303.2 [IN6][1]	Basement wall interior insulation installed per manufacturer's Instructions.			☐	☐	☐		
402.2.7 [IN7][1]	Basement wall interior insulation depth.	10 ft or to basement floor	_____ ft	☐	☐	☐		
402.2.11 [IN8][1]	Sunroom wall insulation R-value.	R-13	R-_____	☐	☐	☐		
303.2 [IN9][1]	Sunroom wall insulation installed per manufacturer's Instructions.			☐	☐	☐		
402.2.11 [IN10][1]	Sunroom ceiling insulation R-value.	R-24	R-_____	☐	☐	☐		
303.2 [IN11][1]	Sunroom ceiling insulation installed per manufacturer's instructions.			☐	☐	☐		
402.4.2, 402.4.2.1 [IN12][1]	Air sealing complies with sealing requirements via blower door test. If	ACH 50 ≤ 7	ACH 50 = _____	☐	☐	☐		

[7] Or insulation sufficient to fill the cavity, R-19 minimum.

[8] Floor steel frame equivalent: R-19+R-6 in 2x6 or R-19+R-12 in 2x8 or 2x10

[9] If more than ½ the insulation is on the exterior, mass wall exterior insulation requirement applies (R-13).

[10] Wall steel frame equivalent: R-13+R-10; R-19+R-9; R-25+R-8.

	applicable, verification via visual inspection should be marked N/A.							
303.1 [IN13][2]	All installed insulation labeled or installed R-value provided.			☐	☐	☐		
402.4.1, 402.4.2 [IN14][3]	Air sealing of all openings and penetrations via visual inspection: • Site-built fenestration • Window/door openings • Utility penetrations • Attic access openings If applicable, verification via blower door should be marked N/A.			☐	☐	☐		
402.4.1, 402.4.2 [IN15][3]	Air sealing of all envelope joints and seams via visual inspection: • Dropped ceilings • Knee walls • Assemblies separating garage • Tubs and showers • Common walls between units • Rim joist junctions If applicable, verification via blower door should be marked N/A.			☐	☐	☐		
402.4.1, 402.4.2 [IN16][3]	Air sealing of all other sources of infiltration, including air barrier, via visual inspection. If applicable, verification via blower door should be marked N/A.			☐	☐	☐		

Additional Comments/Assumptions: _____

General building information only required if different than above Building ID:_____

Date:_____ Name of Evaluator(s): _____

Building Name & Address:_____ Conditioned Floor Area:_____ ft^2

Building Contact: Name:_____ Phone:_____ Email:_____

Compliance Approach (check all that apply): Prescriptive Trade-Off Performance

Compliance Software Used:_____ Green Building/Above-Code Program:_____

IECC Section #	Final Inspection Provisions	Code Value	Verified Value	Complies				Comments/Assumptions
				Y	N	N/O	N/A	
402.1.1 402.2.1 402.2.2 [FI1][1]	Ceiling insulation R-value.	Wood: R-38[11] Steel Truss[12] Steel Joist: R-49	R-_____ Wood Steel					
303.1.1.1, 303.2 [FI2][1]	Ceiling insulation installed per manufacturer's instructions. Blown insulation marked every 300 ft^2.							
402.2.3 [FI3][1]	Attic access hatch and door insulation.	R-38	R-_____					
403.2.2 [FI4][1]	Duct tightness via post-construction test. If applicable, verification via rough-in test should be marked N/A.	To Outdoors: 8 cfm Across System: 12 cfm	_____ cfm					
403.6 [FI5][1]	Heating and cooling equipment type and capacity as per plans.							
404.1 [FI6][1]	Lighting - 50% of lamps are high efficacy.							
401.3 [FI7][2]	Certificate posted.							
402.4.3 [FI8][2]	Wood burning fireplace - gasketed doors and outdoor air for combustion.							
403.1.1 [FI9][2]	Programmable thermostats installed on forced air furnaces.							
403.1.2 [FI10][2]	Heat pump thermostat installed on heat pumps.							
403.4 [FI11][2]	Circulating service hot water systems have automatic or accessible manual controls.							
403.9 [FI12][2]	Pool heaters, covers, and automatic or accessible manual controls.							

Additional Comments/Assumptions: _____

KEY	1	High Impact (Tier 1)	2	Medium Impact (Tier 2)	3	Low Impact (Tier 3)

[11] R-30 if insulation is not compressed at eaves. R-30 may be used for 500 ft^2 or 20% (whichever is less) where sufficient space is not available.

[12] Steel truss equivalent: R-49; R-38+R-3.