Evaluation of Illinois Baseline Building Code Compliance

Prepared for:

Illinois Department of Commerce and Economic Opportunity

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1. Executive Summary

Effective January 1st, 2013 the State of Illinois adopted the 2012 Illinois Energy Conservation code (IECC 2012) to regulate statewide code requirements for commercial and residential new construction and renovation projects. The IECC 2012 is an Illinois specific amended version of the 2012 International Energy Conservation Code. ADM Associates was tasked with conducting a study to determine the statewide baseline level of code compliance of new construction projects, as the Illinois Department of Commerce and Economic Opportunity Energy Recycling Office (DCEO) seeks to achieve energy savings from implementation of the Building Energy Code Compliance Program (BECP). The BECP provides training and technical assistance to individuals in the residential and non-residential building industry. The study was designed to accomplish the following goals:

- Determine the baseline statewide compliance for both residential and non-residential new construction projects;
- Determine the baseline energy consumption for new construction projects;
- Identifying common areas of non-compliance; and
- Provide recommendations to DCEO on future BECP training alterations.

During the effort to determine the baseline level of code compliance, ADM Associates was assisted by CCJM Engineering in contacting building officials and collecting building construction information for a statistically relevant sample of new construction projects. A sample of new construction projects was generated using the Department of Energy State Sample Generator Tool[1]. The resulting sample included 44 residential and 42 non-residential sites. The assessment of code compliance included evaluation of 30 residential and 13 non-residential new construction sites.

The ADM team initially contacted 96 building jurisdictions across the state through the use of the ADM and DCEO co-written letter of intent. The letter of intent detailed the scope of the compliance study and requested the participation of jurisdictions as the study was not mandatory. After a notification period, follow up calls were to each jurisdiction were made. In the event that contact was not established, messages were left along with follow up emails. Throughout the study additional calls were made to the unresponsive jurisdictions. Even with the additional contact attempts ADM was unable to obtain a full sample. ADM attributes the reduced sample to the following factors:

- Unwillingness of individual jurisdictions to participate;
- Jurisdiction failure to enforce an energy code; and
- Projects canceled after being sampled.

The recentness of the adoption of IECC 2012 also hindered the number of qualifying new construction sites, as the study was limited to projects permitted after January 1st, 2013. Most construction projects experience a delay in starting as ground is not typically broken as soon as

[1] https://energycode.pnl.gov/SampleGen/

permits are issued. This resulted in a number of sites not being far enough along in the construction process to allow for an accurate assessment of code compliance.

Individual compliance rates for each new construction project were determined through the use of the Department of Energy's Pacific Northwest National Laboratory (PNNL) "Score + Store" forms. Each site level "Score + Store" form was filled out through documentation review with building officials as well as site visits to the construction sites.

Residential statewide compliance is based on a straight average of the individual compliance rates, while statewide non-residential compliance rate is based upon a weighted average of the three building size stratums. Through the online "Score + Store" tool, it was determined that the participating residential new construction projects have an overall compliance with IECC 2012 of 81.3%. A compliance rate for non-residential projects was unable to be determined due to the lack of statewide new construction projects and participation along with the determination of baseline energy consumption for the initial adoption of IECC 2012.

Reduced residential compliance was most commonly attributed to 1) failure to perform duct blasting tests when necessary and 2) failure to provide and perform ACCA Manual J and S HVAC sizing calculation (which also prevented the verification of HVAC sizing and equipment at location).

The initial baseline energy consumption for residential projects in regards to IECC 2012 was determined through the use of the BECP residential prototype models developed by The Pacific Northwest National Laboratory (PNNL). Using information collected during visits to both the building department and the construction sites, a pair of prototypical models was derived to represent current construction practices in the two weather zones located in Illinois. From these models it was determined that an average residential home in Weather Zone 4 consumed 130.92 Million Metric British Thermal units (MMBtu) resulting in 2.87 MMBTU or 2.2% more than a 100% compliant home located in the same weather zone. The typical home in Weather Zone 5 consumed 137.23 MMBtu annually which is 3.08 MMBtu or 2.2% less than a 100% compliant home located in the same weather zone.

Energy simulations illustrate that a higher level of compliance does not necessarily indicate a higher level of energy efficiency. There are number of sections within the PNNL checklists that do not have a direct impact on the energy consumption of projects. This leads to sites that have a reduced energy code compliance rate but have an annual energy consumption that is less than or equal to an IECC 2012 compliant site, meaning that the home uses less energy than allowed by the energy code.

The similar annual energy consumption of the prototypical models as compared to the compliance models cans be attributed to natural market adoption and social trends. "Energy Efficiency" and "Green" are prevalent subject manners in today's society. Home builders are using this as a selling point for new construction homes which leads to the increase of more efficient homes in the market place.

Due to the nature of the study, the participating sampled sites cannot be considered strictly random. In jurisdictions for which energy codes are not enforced, sites were not sampled due to the lack of project documentation and/or administrative resources to assist in the study. Smaller

jurisdictions that were unable to enforce building energy codes were also not sampled due to the lack of compliance documents needed to perform the study. This is also the case for jurisdictions that refused to cooperate with the study. This leads ADM to believe that the PNNL BECP methodology for determining statewide compliance will tend to skew the results slightly upward. That is, the energy code compliance rate for the state is likely lower than 81.3%. In order for this to be remedied, the participation by all state jurisdictions would need to be mandatory.

2. Introduction

This purpose of this report is to present the results of the Baseline Compliance Study for the Building Energy Code Compliance Program that the Illinois Department of Commerce and Economic Opportunity (DCEO) offer to building professionals. This report estimates baseline energy consumption of new residential homes and non-residential facilities and compares their performance to an IECC 2012[2] minimally compliant building. This comparison is used to review the current statewide compliance to IECC 2012 and estimate energy use impacts due to non-compliance.

2.1 Program Description

The Building Energy Code Compliance Program offered by DCEO is designed to help buildings achieve a 90% compliance rate in accordance with the enforced energy code for all new construction and renovation projects. The explanation of the program and the methodology utilized to determine the statewide baseline compliance of the IECC 2012 and baseline energy consumption is as follows. The Building Energy Code Compliance Program (BECP) provides training to individuals in the residential and non-residential building industry. The objective of the program is to increase the understanding and compliance with the IECC 2012, effective as of January 1st 2013, and insure that the state of Illinois achieves a 90% compliance rate. Increased compliance with the code is intended to produce energy savings through the construction of more efficient buildings.

The DCEO BECP training currently offers energy compliance training to interested parties. This training is broken into five separate courses in which the following topics are covered; Compliance and Documentation of IECC 2012, Using REM/Rate™ and REM/Design™ as Compliance Tools, Right-Sized HVAC Design for Code Compliance, and two courses on Commercial Energy Modeling. An up to date list and in-depth explanation of DCEO's current training offerings can be found on their website[3].

2.2 Baseline Compliance Study

The DCEO seeks to determine the state's energy compliance rates using a methodology developed by the Department of Energy's Pacific Northwest National Laboratory (PNNL). The PNNL methodology includes a description of how to develop samples for the assessment of code compliance and a standardized checklist approach for assessing code compliance. The standardized checklists are referred to as "Score + Store," forms and are designed to create a homogenous method for determining code compliance using a three tier points system, which are awarded on a pass/fail criterion. Upon the evaluation of a full sample, individual compliance rates are combined using a weighted average method to determine the overall statewide compliance for residential and non-residential new construction projects. If the statewide

[2] The 2012 Illinois Energy Conservation Code (IECC 2012) went into effect on January 1st, 2013.

[3] www.ILDCEO.net/energycode

compliance rate is above 90%, the state is considered to be compliant to the IECC 2012 energy code.

The overall objective for the Baseline Compliance Study is to assess the statewide compliance of the IECC 2012 and the baseline energy consumption of residential and non-residential new construction projects.

The approach for the Baseline Compliance Study had the following main features.

- Utilizes the U.S. Department of Energy's Building Energy Codes Program's (BECP) methodology and tools to assess compliance in new non-residential and residential buildings with the 2012 IECC.
- Building Departments from the sampled counties were contacted using the provided intent letter from DCEO, in order to gain access to current new construction projects.
- Available documentation (e.g., construction dockets, REScheck™ and COMcheck™, etc) for projects permitted after January 1st, 2013 were reviewed for code compliance.
- When possible, projects that were currently under construction were visited to ensure code compliance was maintained throughout the construction process.
- "Score + Store" were used to determine individual project compliance along with statewide compliance.
- Department of Energy prototypical models were used to calculate the baseline energy consumption for residential new construction projects.

3. Code Compliance Assessment Methodology

This chapter addresses the methodology used to estimate statewide non-compliance and the baseline energy consumption for residential and non-residential new construction projects. The study focuses on projects permitted after January 1st, 2013 (the date at which IECC 2012 went into effect state-wide).

3.1 Sample Selection

The sample for this study was generated using the PNNL methodology. Sampling was performed for residential new construction and nonresidential new construction projects. The objective of this study was to sample a minimum of 44 residential buildings and 42 nonresidential buildings. However, due to reservations within individual municipalities and limitations with new construction projects, ADM was only able to secure 30 residential buildings and 13 nonresidential buildings. 31 residential sites were originally sampled; however, during a follow up interview it was discovered that one project was canceled due to financial reasons. Due to the project not going to construction ADM opted to remove the site from the sample.

3.1.1 Residential Building Sample

Residential construction includes one- and two-family attached and detached dwellings, town homes, and multifamily structures three stories or less above grade and containing dwelling units. All other residential construction, including buildings such as hotels and motels, were considered commercial buildings.

The Department of Energy State Sample Generator Tool[4] was used to generate a sample of residential buildings distributed across jurisdictions and ASHRAE Weather Zone 4 and Weather Zone 5. Table 3-1 shows the recommended sample created from the sample generator tool based on 2009 and 2010 new construction starts. 44 buildings are prescribed for the sample. The sample is designed with 5% precision at the 95% confidence interval.

[4] https://energycode.pnl.gov/SampleGen/

Table 3-1 Sample Size for Residential New Construction Based on 2009-2010 Annual Construction Starts

Location	*Total Permits*	*Sample Size*
State Total	8,149	44
Climate Zone 4 Total	1,837	10
Bond County	31	1
Clinton County	117	2
Madison County	430	2
Shelby County	64	1
St. Clair County	596	3
Union County	32	1
Climate Zone 5 Total	6,312	34
Calhoun County	14	1
Champaign County	287	4
Cook County	814	4
DuPage County	433	1
Grundy County	63	1
Henderson County	17	1
Jo Daviess County	41	1
Kane County	529	3
La Salle County	72	2
Lake County	462	2
Macon County	95	1
McLean County	327	1
Peoria County	242	4
Sangamon County	324	2
Tazewell County	238	2
Will County	489	1
Winnebago County	210	3

3.1.2 Nonresidential Building Sample

The PNNL methodology stratifies non-residential buildings across three size categories (small, medium, and large) in addition to county. Two additional size categories are strata (x-large and xx-large) where appropriate; however, these were not found necessary in this compliance assessment. The following are definitions for the size categories:

- Small: 1-2 stories, single zone, up to 25,000 ft^2 in conditioned area;
- Medium: Larger than 25,000 ft^2 and up to 60,000 ft^2;
- Large: Larger than 60,000 ft^2 and up to 250,000 ft^2.

The Department of Energy State Sample Generator Tool[5] was used to generate a sample of non-residential buildings stratified across jurisdictions, climate zones, and building size. Table 3-2 shows the sample created by the sample generator tool based on 2009 and 2010 new construction starts. 42 buildings are prescribed for the non-residential sample. The sample is designed with 5% precision at the 95% confidence interval.

Table 3-2 Sample Size for Non-residential New Construction Based on 2009-2010 Annual Construction Starts

Location	*Construction Starts*	*Building Size Strata*		
		Sample Size Small	*Sample Size Medium*	*Sample Size Large*
State Total	581	14	14	14
Climate Zone 4 Total	76	2	2	2
Jackson County	8	-	1	-
Jefferson County	3	1	-	-
Madison County	15	1	1	1
St. Clair County	15	-	-	1
Climate Zone 5 Total	505	12	12	12
Adams County	6	-	1	-
Champaign County	20	1	-	-
Coles County	5	1	-	-
Cook County	164	2	7	7
Dupage County	41	3	2	1
Grundy County	5	1	-	-
Henry County	5	2	-	-
Kane County	27	-	1	2
Lake County	29	1	-	1
Peoria County	11	-	1	1
Tazewell County	7	1	-	-

3.1.3 Calculating Statistical Confidence for Compliance Rate

Confidence intervals were calculated at a 95% confidence level using the following equation:

$$\bar{x} \pm 1.645 \times \frac{s}{\sqrt{n}}$$

Where,

$\bar{x}$ = mean

s = standard deviation

n = number of buildings in sample (in this case, the number of obtained sites)

[5] https://energycode.pnl.gov/SampleGen/

From a statistical perspective, we are 95% confident that the compliance rate for the population falls within the confidence interval. If the confidence interval contains 0.9 we can conclude that the sample of buildings evaluated gives evidence that Illinois has demonstrated a 90% compliance rate.

3.2 Data Collection and Analysis

Data necessary for determining baseline compliance and annual energy usage was acquired through interviews with building officials, reviewing project documentation, and visits to the construction sites. This allowed ADM to review compliance throughout the construction process and identify areas in which improvements and additional training are needed. Annual baseline energy consumption for typical residential constructions was calculated through the use of the BECP residential prototype models developed by The Pacific Northwest National Laboratory (PNNL) which operate on the EnergyPlus platform. Baseline energy consumption for non-residential new construction sites was calculated through the development of site specific eQuest models. The results of the individual models were then to be aggregated to the number of new construction starts shown in Table 3-2.

3.2.1 Documentation Review and Data Collection Procedures

ADM followed the methodology set forth by the U.S. Department of Energy's Building Energy Codes Program's (BECP) in documentation review and data collection. The BECP methodology relies on a library of data collection forms. Specific forms are available for residential and non-residential new construction projects, the energy code(s) against which compliance is being assessed, and the weather zone(s) in which the projects are located. The "Score + Store," forms are designed to create a homogenous method for determining code compliance using a three tier points system, which are awarded on a pass/fail criterion.

Each section of the "Score + Store" form is separated into two categories; one for plan verification and the other for site verification. The plan verification section is populated based upon documentation reviews performed at the municipality offices. The provided document types included: REScheck™, REM/Rate™, and COMcheck™ reports. Architectural plans were also reviewed to determine that all of the appropriate information was entered into the fore mentioned compliance programs.

Where site visits were permitted, field staff completed the second category of the "Score + Store" form. During site visits, staff was accompanied by building department officials, and/or the builder. On site, information collected during the initial plan check was compared to the actual practices being employed during the construction process. Note that not all equipment and/or envelope components could be verified during a single site visit as sites were visited at various stages of completion. Multiple site visits and follow up interviews were performed when permitted in an effort to collect post construction data (for example blower door testing and duct blasting results).

3.2.2 Method Used to Determine Compliance and Estimate Energy Consumption in Residential New Construction

Compliance rates for residential new construction project were determined using the "Score + Store" forms. Data collected on the "Score + Store" forms allowed ADM to quantify site code compliance according to its compliance path. Possible compliance paths include: prescriptive, trade-off, and performance. The compliance path must be considered carefully when assessing code compliance – particularly when a site utilizes the trade-off or performance path. A particular component may not pass the prescriptive requirements but is ultimately deemed compliant due to trade-off allowances. An example of this is as follows:

- A residential construction project achieves compliance through the use of the UA trade-off method. Because of this, the contractor installed R-19 in the walls as opposed to the prescriptive requirement of R-21. The reduction in wall insulation is then compensated for by installing increased insulation in the attic, thus allowing the envelope to pass UA trade-off requirements.

Construction details collected by the forms are ranked on a three tier system according to their impact on code compliance. Tier I sections of code are considered "high impact" and if a Tier I parameter is found to be compliant then the section of code is awarded three points. Tier II sections are considered "medium impact" and are awarded two points. Tier III sections are considered "low impact" and are awarded one point when found compliant. In the advent that it is determined that a construction is non-compliant, zero points are awarded for the applicable section of code. Upon the scoring of each applicable section of code, all awarded points point are divided by the possible number of points to determine the compliance rate for a given project. The statewide compliance is then determined by averaging the compliance rates across all sampled homes. If the compliance rate is determined to be above 90%, the state is considered compliant in regards to the enforced energy code. It should be noted that since the checklists use a tiered point structure, 90% compliant does not mean that the state or a particular home is compliant with 90% of the applicable sections of code.

The statewide baseline energy consumption, in reference to IECC 2012, for residential new construction projects was determined using the BECP residential prototype models, developed by The Pacific Northwest National Laboratory (PNNL). The PNNL compliance models represent a typical constructed home that is 100% energy compliant in regards to the requirements set forth by IECC 2012. ADM modified the PNNL model to create two reference model variants. One *code-compliant* and one *prototypical construction* model were developed for each of the two weather zones. The compliance model represents a typically size home as determined by the data collection efforts, and is considered 100% compliant in regards to IECC 2012. The prototypical construction model represents a typically sized home which is constructed according to the average verified U-factors identified during the study. These modified versions of the PNNL models were informed by site specific construction details collected during ADM's plan review and on-site inspections. Site specific details were normalized to conditioned area and envelope surface areas in order to incorporate them into the reference models. The following site specific details were used in the normalization process:

- Conditioned Area
- Home Orientation
- Ceiling Insulation Area and U-factors
- Above Ground Wall Insulation Area and U- factors
- Window Area and U- factors
- Door Area and U- factors
- Basement Wall Insulation Area and U- factors
- Floor Insulation Area and U- factors
- Blower Door Results (Air Changes Per Hour)
- Duct Blasting Results (CFM/100ft^2)
- HVAC Duct R-Values

Each compliance and prototypical reference model was then run using the appropriate TMY3 Climate Zone 4 and 5 weather file.

Modifications to the PNNL models were necessary to determine the effects of the duct leakage and insulation as the original models did not include a detailed duct system. ADM modified the models to utilize the air flow network component of EnergyPlus. This allows for the specification of the duct work: length, R-value, and leakage.

3.2.3 Method Used to Determine Baseline Compliance and Estimate Energy Consumption in Non-Residential New Construction

Compliance rates for residential new construction project were determined using the "Score + Store" forms. Data collected on the "Score + Store" forms allowed ADM to quantify site code compliance according to its compliance path. Possible compliance paths include: prescriptive, trade-off, and performance. Consideration of the compliance path must be given when assessing code compliance in a similar manner as described in Section 3.2.2. Scoring of the non-residential forms is performed in an identical manner as the residential forms. Upon the scoring of each applicable section of code, all awarded points point are divided by the possible number of points to determine the compliance rate for a given project. Once the compliance of each of the sampled projects has been determined, the statewide percent compliance is determined by applying a weighted average method. The weighted average is based upon the number of construction starts in a building size stratum. If the overall compliance rate is determined to be above 90%, the state is considered compliant in regards to the enforced energy code. It should be noted that since the checklists use a tiered point structure, 90% compliant does not mean that the state or a particular building is compliant with 90% of the applicable sections of code.

Baseline energy consumption for the non-residential new construction projects was quantified using site specific eQuest models. The site specific models were informed by building construction data collected during ADM's documentation review and on-site inspections. The models could not be calibrated to billed energy usage (as is standard practice) due to lack of sufficient billing data. This also impacted model inputs such as operating schedules and temperature set points which had not yet been established for the reviewed facilities. If schedules

where not readily available, schedules and set points from the Database of Energy Efficient Resources (DEER) prototypical models were used

4. Code Compliance Findings

This chapter presents the findings of the baseline compliance study. This chapter includes the overall energy compliance rate for the state and baseline energy consumption of residential new construction projects.

4.1 Jurisdictional Participation

The initial statewide compliance of IECC 2012 was determined through the use of the PNNL "Store + Store" forms. The assessment of code compliance included the review of 30 residential and 13 non-residential new construction projects. A full sample of residential and non-residential locations was not able to be obtained due to a multitude of reasons. The most common limitations were an unwillingness of some jurisdictions to participate, non-response from contacted officials, and a lack of new construction projects at the time of the study.

During the initial contact phase of the baseline study, 96 jurisdictions were contacted to inquire about potential qualifying sites and willingness to participate in the study. During the surveys of individual jurisdictions, it became evident that many departments were either not willing or did not have the available resources to participate in the study. Some departments also stated that they did not have the "man power" to enforce an energy code, and because of this, the documentation needed to perform the study would not be available. This occurred predominantly in smaller counties (with an average population of less than 45,000). A majority of these jurisdictions indicated that they had not yet adopted IECC 2012, which is likely one of the contributors for non-participation. It should also be noted that some jurisdictions within larger counties were also unwilling to participate; however, due to a greater number of jurisdictions within larger counties, sample points were able to be obtained from other jurisdictions that were willing to participate.

The nature of the study also contributed to the low participation rates. IECC 2012 was adopted by the state of Illinois on January 1st, 2013. Because of this, sites could only be sampled if they were issued a permit after January 1st, 2013. This limited the number of qualifying new construction projects due to the typical construction time frame for non-residential projects. Table 4-1 provides a summary of responses received from the contacted jurisdictions during the baseline compliance study.

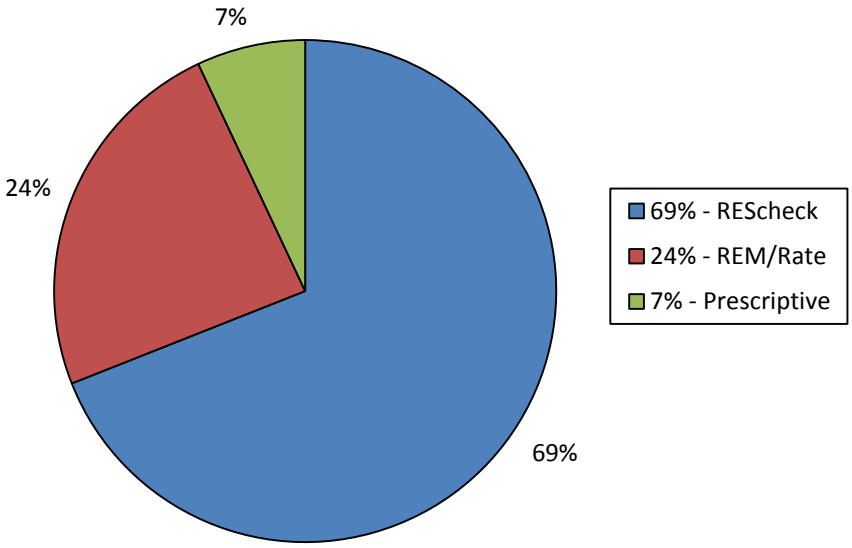
Table 4-1 Jurisdiction Establishment of Contact

Response	*Number of Jurisdictions*
Contacted	96
Participated	24
No New Construction	17
No Energy Code Enforced	14
Unresponsive	28
Unwilling to Participate	2

4.2 Baseline Statewide Residential Compliance

The baseline compliance rates for each residential new construction project was determined using PNNL "Store + Score" forms. A simple average of the individual compliance rates resulted in an overall compliance rate of 81.3%, in regards to the minimum construction requirements set forth by IECC 2012. Of the reviewed projects, the builders and building departments utilized one of three methods in order to document energy compliance: prescriptive, trade-off, and performance. During the study it was identified that the most common software used to document compliance for the trade-off method was REScheck™, while Rem/Rate™ was used for performance based compliance. Figure 4-1 shows the distribution of the residential compliance approaches verified during the baseline study.

Figure 4-1 Residential Compliance Approach Distribution



4.2.1 Statistical Confidence for Compliance Rate

From a statistical perspective, we are 95% confident that the compliance rate for the population falls within the confidence interval. We are 95% confident that the compliance rate is between 78.1% and 84.5%. Table 4-2 below summarizes the mean, standard deviation, number of observations, margin of error, and the upper and lower bounds of the confidence interval.

Table 4-2 Sample Statistics

Statistic	*Value*
Mean	0.813
Standard Deviation	0.089
Number of Observations	30
Margin of Error	0.027
Upper Bound	0.845
Lower Bound	0.781

Because the confidence interval does not contain the value 0.9, we conclude with 95% confidence that Illinois has not demonstrated a 90% compliance rate.

4.2.2 Baseline Residential Energy Consumption

During the baseline compliance study, the construction details of each residence were recorded through the use of a tracking database. Collected construction details included; surface areas of walls, windows, doors, floors and ceilings, along with corresponding U-factor for each. Using the data collected on site and through documentation reviews, the typical construction for a residence in ASHRAE Weather Zone 4 and Weather Zone 5 was calculated using a weighted average method based upon conditioned area. Table 4-3 and Table 4-4 compare the prototypical and compliant constructions seen in the two weather zones. Prototypical construction refers to the typical construction identified throughout Illinois during the data collection process, while IECC 2012 represents a home that is built to the exact specifications set forth by the enforced energy code.

Table 4-3 ASHRAE Weather Zone 4 Residential Construction

		IECC 2012	*Prototypical*
Conditioned Area		4,161	
Orientation		165°	
Total UA		502.79	478.98
Ceiling	Area (ft^2)	2,265	
	U-Factor	0.0260	0.0260
Walls	Area (ft^2)	2,379	
	U-Factor	0.0570	0.0733
Windows	Area (ft^2)	413	
	U-Factor	0.3500	0.3053
	SHGC	0.4000	0.2764
Doors	Area (ft^2)	39	
	U-Factor	0.3500	0.2288
Basement Walls	Area (ft^2)	1,953	
	U-Factor	0.0730	0.0546
Floors	Area (ft^2)	158	
	U-Factor	0.0470	0.0248
HVAC	Blower Door (ACH@50 Pa)	5.00	3.02
	Duct R-Value	6.00	6.00
	Duct Leakage (CFM/100ft^2)	4.000	3.514

Table 4-4 ASHRAE Weather Zone 5 Residential Construction

		IECC 2012	*Prototypical*
Conditioned Area		3,864	
Orientation		122°	
Total UA		468.41	442.83
Ceiling	Area (ft^2)	2,093	
	U-Factor	0.0260	0.0267
Walls	Area (ft^2)	2,802	
	U-Factor	0.0570	0.0603
Windows	Area (ft^2)	429	
	U-Factor	0.3200	0.2810
	SHGC*	0.4000	0.4000
Doors	Area (ft^2)	42	
	U-Factor	0.3200	0.2401
Basement Walls	Area (ft^2)	1,562	
	U-Factor	0.0620	0.0524
Floors	Area (ft^2)	135	
	U-Factor	0.0330	0.0280
HVAC	Blower Door (ACH@50 Pa)	5.00	3.92
	Duct R-Value	6.00	5.85
	Duct Leakage (CFM/100ft^2)	4.000	3.792

*Note: There are no SHGC requirements for Zone 5. Therefore both models were run with a SHGC of 0.4000.

The above inputs were entered into the PNNL prototypical models using parametric runs. This allowed for the determination of the current energy consumption for a typical home construction, along with the reference energy consumption for a 100% compliant home. For instances in which a construction could not be visually verified on site, ADM sourced construction details from the energy compliance documentation and/or construction plans to be used as model inputs.

Each set of models was run using the appropriate weather file. The comparisons of energy usage for IECC 2012 compliant and prototypical baseline models can be seen below in Table 4-5 and Table 4-6.

Table 4-5 ASHRAE Weather Zone 4 Residential Energy Consumption

	IECC 2012	*Prototypical Baseline*	*Difference Above Code*
Total Usage (MMBtu/yr)	128.06	130.92	2.87
Annual Usage (kWH/yr)	13,772	13,642	-129
Annual Usage (Therms/yr)	810.65	843.72	33.07

Table 4-6 ASHRAE Weather Zone 5 Residential Energy Consumption

	IECC 2012	*Prototypical Baseline*	*Difference Above Code*
Total Usage (MMBtu/yr)	140.31	137.23	-3.08
Annual Usage (kWH/yr)	12,215	12,278	63
Annual Usage (Therms/yr)	986.30	953.36	-32.94

The energy consumption difference between the IECC 2012 compliant model and the prototypical model in ASHRAE Weather Zone 4 can be attributed to the reduced window solar heat gain coefficient (SHGC) values. Through the comparisons of the parametric run outputs, it was determined that the lower SHGC of the prototypical windows resulted in higher heating costs due to the solar heating gains through windows being significantly reduced. This negative impact outweighs the overall benefit of a lower total UA for a residence.

The results of ASHRAE Weather Zone 5 can be attributed to the insulative properties that soil has on basement walls. When comparing the total UA values of the ceiling, above ground walls, and basement walls, the prototypical model has an overall lower UA. However, the increased U-factor of the ceiling and above ground walls cannot be offset by the observed decrease in basement U-factor, from a heat transfer point of view. This is due to the reduced temperature difference between the soil and conditioned space of the basement, as ground temperature is warmer than outdoor air during the winter and cooler in the summer. ASHRAE Weather Zone 5 is dominated by heating loads due to the lower average temperatures, which exaggerates the negative impacts of the reduced above ground insulation.

The results of the prototypical simulations suggest that residential energy consumption is not directly related to the percent compliance of a home as defined by the PNNL "Score + Store" forms. This can be attributed to some sections within the forms having little to no impact on the energy consumption of the home.

Section R303.1 requires all installed insulation to have labels or documentation of installed R-values. If this information cannot be verified, it will trigger non-compliance; however, this will have no impact on the overall energy consumption of the home. For this particular measure, it is possible to verify the installed R-values using other verification methods such as measuring insulation depth or consulting purchase invoices. It is usually the case that though labels are not always present, the insulation did in fact meet minimum code requirements.

This is also demonstrated in section R303.1.1.1 which specifies that, for blown-in insulation installations, the attic shall be marked every 300 ft^2 in which the marker faces the attic hatch. If one is to enforce the code verbatim, simply having depth markers not facing the attic hatch would trigger non-compliance. Again, this does not impact energy consumption of the residence. The markers simply help to ensure that proper depth of insulation has been installed. If it were permissible for the inspector to verify without the necessity of depth markers, the insulation installation would likely meet the code requirement.

Other sections of IECC 2012 that contain specifications that have no impact on energy consumption are contained in section R401.3 which requires the posting of the compliance certificate in the electrical panel. Additionally, section R303.3 requires the mechanical and water

heating equipment manuals to be presented to the home owner. These sections are assigned Tier II and III scores within the compliance form and do not have an impact on the annual energy consumption of the home.

4.2.3 Common Areas of Non-Compliance

During the baseline documentation reviews and field inspections there were common areas of non-compliance discovered, along with errors that presented false compliance. Non-compliance presented itself in both the documentation review and in current construction practices. The identified issues are discussed in the subsections below.

4.2.3.1. REScheck Ceiling Insulation Inputs

When entering ceiling insulation R-values into REScheck™, there are two available input fields. These input fields include "Cavity" and "Continuous" for potential insulation installation types. During the documentation review process, it was common to see the ceiling insulation R-value being divided among the two software entry fields. This most commonly occurred when the builder/contractor opted to install loose-fill/blow-in insulation. According to the REScheck™ help file, the entire R-value for blown-in insulation shall be entered in the "Cavity" field. The practice of dividing the installed insulation across the two fields results in an overall lower U-factor, which can result in an inaccurate representation of compliance. This is due to the REScheck™ UA-Trade Off method where installed envelope insulation requirements are distributed among the loose-fill insulation installed in the interstitial roof-joist-cavities and the loose-fill piled on-top of those very same roof joists below. An example of this inaccuracy, or false compliance, can be seen in Table 4-7 below:

Table 4-7 REScheck Ceiling Insulation

Insulation	*Example #1*	*Example #2*
Cavity R-Value	18	48
Continuous R-Value	30	-
Total R-Value	48	48
Overall U-Factor	0.020	0.026

4.2.3.2. ACCA Manual S and J HVAC Sizing Calculations

Of the 30 sampled sites, six (6), supplied Manual S and Manual J calculations performed by software "Powered by ACCA Manual J". For sites documenting compliance through the use of REM/Rate™, which follows the performance path (i.e., Section 405 analysis), it was common to see the HVAC equipment selections being accepted for IECC 2012 Sections R302.1 and R403.6 requirements. The afore mentioned sections require heating and cooling equipment to be sized in accordance with ACCA Manual S where home heating and air-conditioning loads have been calculated in accordance with ACCA Manual J. According to the ACCA acceptable software page[6], REM/Rate™ is not accepted software for performing residential HVAC sizing calculations. Of the seven residential sites that used REM/Rate™, only one site provided additional Manual S and Manual J sizing calculations. For homes that used REM/Rate™ outputs

[6] http://www.acca.org/standards/software/

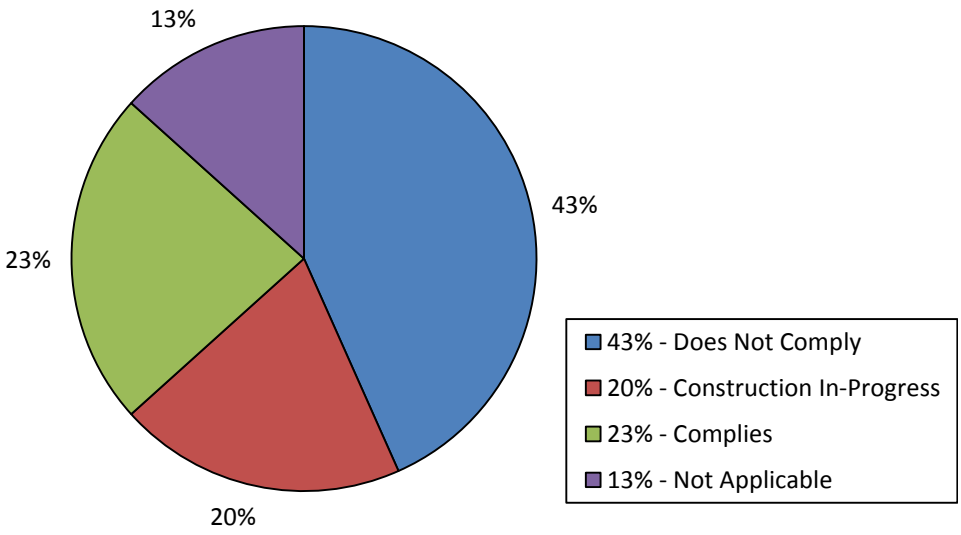
for HVAC sizing, the home would be considered non-compliant for the applicable section of IECC 2012 and receive zero points in the scoring section.

The available information discussing the impacts that right sizing has on annual energy consumption is somewhat limited. A publication submitted to the 2008 ACEEE Summer Study on Energy Efficiency in Buildings conference claims that "oversizing air conditioners by 100 to 150% above ACCA Manual J can increase peak demand by 20 to 50% and increase energy use by 2 to 5%."[7] Quantifying the impacts that right-sizing home heating and air-conditioning systems compared to those homes without would have within the state of Illinois would need to be calculated on a site by site basis and would require an additional study. Sizing calculations are not able to be performed with the collected compliance documentation. Due to this and state specific right-sizing home heating and air-conditioning impacts not being readily available, ADM opted to assume home were right-sized in the energy simulations.

4.2.3.3. HVAC Duct Leakage

Duct leakage has a large impact on the energy efficiency of a home due to conditioned air escaping into unconditioned spaces. Section R403.2.2 requires that the leakage across the system be no greater than 4 cfm/100ft^2 of conditioned space. However, if the ducts are located entirely within conditioned space, the duct network is exempt from this requirement. Figure 4-2 illustrates the results of the residential duct leakage effort.

Figure 4-2 Residential Duct Leakage Compliance



During the baseline study it was discovered that a majority of the homes' duct work was not tested and as a result, failed compliance for the section as duct leakage test are required for all duct work located in non-conditioned spaces. However, of the homes that supplied duct blasting results, all of the reported leakage rates were below the maximum allowable leakage of 4.00

[7] Pg. 1-205: http://aceee.org/files/proceedings/2008/data/papers/1_692.pdf

cfm/100ft^2, with the exception of one home that had a reported leakage of 4.32 cfm/100ft^2. The home with the reported leakage above the maximum allowable threshold, fails compliance due to not meeting set requirements. From the reported duct blasting results it leads ADM to believe that the current common construction practices being performed within the state result in duct work having less leakage than the maximum allowed by IECC 2012.

Of the sites that did not comply with duct blasting and leakage requirements, all failed to require and/or perform duct blasting except for three. For those three sites, it was noted that all of the duct work was located in conditioned areas; therefore, duct sealing requirements were not applicable. However, during sites inspections it was discovered that each of the three homes contained ducts that were located in the unconditioned attic portion of the home. Since these ducts were located in unconditioned spaces, duct blasting tests are required. Because of this, the sites failed compliance for this requirement.

4.3 Baseline Statewide Non-Residential Compliance

Due to low participation in the non-residential category, a statewide compliance rate was not determined. This is due to the number of sampled sites not being statically relevant. ADM felt it was necessary to document the areas of non-compliance in the non-residential sampled sites, which are discussed in the following sections.

4.3.1 Common Areas of Non-Compliance

During field inspections and baseline documentation reviews there were common areas of non-compliance discovered, along with errors that presented false compliance. Non-compliance was identified in both the envelope and lighting systems of the sampled new construction projects. The identified issues are discussed in the subsections below.

4.3.1.1. COMcheck Lighting Inputs

Non-residential lighting presented the most common area in which errors were made when documenting compliance. The most significant energy impacting error came from sites improperly using space-by-space lighting power densities (LPD) when whole building LPD would have been a more appropriate approach.

An example of this was identified in a newly constructed health clinic. The provided energy compliance documentation showed that the allowable whole building LPD was claimed to be 1.7 w/ft^2. Through further review of IECC 2012 it was discovered that the referenced LPD of 1.7 w/ft^2 is to be used for healthcare clinic and hospital exam rooms when utilizing a space by space method. This would have been an acceptable approach if each space within the facility had been broken out. Instead, the whole facility was claimed as if they were exam rooms. Had the whole building method been appropriately selected, the allowable LPD would have been 1.0 w/ft^2. This caused the site to fail interior lighting compliance, as the installed whole building LPD was actually closer to 1.64 w/ft^2.

It was also discovered that the flooring area within the lighting section of the COMcheck was generally over stated as compared to the area being reported in the envelope section. When this practice was discovered for a given site, it was determined through plan reviews that the claimed area in the envelope portion of the COMcheck was typically correct. This overestimation of area

in the lighting portion allowed buildings to increase their maximum allowable wattage and pass interior lighting requirements. When the reported floor area was corrected, sites would fail IECC 2012 interior lighting requirements.

4.3.1.2. COMcheck Envelope Inputs

It was occasionally discovered that not all surfaces of a building were entered into the envelope portion of COMcheck. In one such instance it was identified that the building's glass entry doors were not included in the UA-trade off calculation. Through on-site verification and interviews with the building's architect it was determined that the addition of the glass entry doors would cause the site to fail the envelope portion of the COMcheck.

5. Conclusions & Recommendations

This chapter reports the key conclusion and recommendations resulting from the Baseline Code Compliance Study.

5.1 Key Conclusions

Due to the nature of the study, the participating sampled sites cannot be considered strictly random. In jurisdictions for which energy codes are not enforced, sites were not sampled due to the lack of project documentation and/or administrative resources to assist in the study. This is also the case for jurisdictions that refused to cooperate with the study. This leads ADM to believe that the BECP methodology for determining statewide compliance will tend to skew the results slightly upward. That is, the residential compliance rate in regards to IECC 2012 construction requirements for the state is likely lower than 81.3%. In order for this to be remedied, the participation by all state jurisdictions would need to be mandatory.

Smaller jurisdictions, primarily located in southern Illinois, are particularly limited in their abilities to enforce building codes. Building departments maintained that due to the lack of departmental budgets and available resources, many builders were left to their own accord to build to energy code requirements. Some jurisdictions also stated that they did not foresee current or near-future adoption of IECC 2012 as they felt it would hinder new construction projects in the area.

The recentness of the adoption of IECC 2012 appeared to hinder the number of qualifying non-residential new construction sites. Due to the slow pace at which non-residential sites are typically permitted and constructed, the evaluation team was informed by many jurisdictions that there were projects in the design phase but final permits had yet to be granted. This limited the number of potential sample sites available for the study.

A higher level of compliance does not necessarily indicate a higher level of energy efficiency. This is demonstrated in the prototypical model results in Section 4.2.2 which estimates the difference in energy consumption between prototypical and IECC 2012 code-compliant residences. This can be attributed to some constructions resulting in higher efficiency than others; however, this is not reflected in the compliance rate.

To provide an example, assume two buildings are identical in layout, square footage and construction. Building “A” however, has installed R-13 in above ground walls and R-21 in basements walls, while Building “B” installed R-21 in above ground walls and R-13 in basements walls. Both homes would pass the REScheck^{TM} UA Trade-off method and would result in the same compliance rates. Due to above ground walls experiencing higher outside air temperature swings compared to the basement walls, building “B” would ultimately be more energy efficient. This is due to above ground walls having a higher heat transfer potential, and therefore a greater impact on energy consumption.

The example above also demonstrates that the UA Trade-off method is not always an appropriate determination of energy compliance as a determinate of energy consumption.

It is believed by ADM that the similar annual energy consumption of the prototypical models as compared to the compliance models cans be attributed to natural market adoption and social

trends. “Energy Efficiency” and “Green” are prevalent subject manners in today’s society. Home builders are using this as a selling point of new construction homes which leads to the increase of more efficient homes in the market place. Other contributors to natural market adoption are the window manufacturers. Manufacturers are no longer creating inefficient windows in respect to the various energy codes being enforced across the nation. This in itself is helping to guide newly constructed homes on a path of overall energy efficiency.

5.2 Recommendations

The amount of time that has elapsed after the adoption of an updated energy code affects the number of possible sites that are available to sample for evaluation purposes. Sites available for sample selection were limited to projects that were permitted after the adoption date (in this case, after January 1, 2013). For future evaluations, waiting until a longer period of time has elapsed after the adoption date would ensure the following:

- Greater likelihood for a higher number of potential sample sites and therefore a higher number of sites in each sample (residential and non-residential)
- Construction projects would likely be farther along and not in early building stages (projects closer to completion result in higher compliance accuracy)
- Many jurisdictions encounter delays with regard to code enforcement

For a higher level of accuracy within each individual new construction project, city and county building departments would need to notify evaluators after each completed phase of project. This would help to lessen or eliminate having to select “non-observable” for codes that cannot be verified as compliant as the construction of the project is too far along.

Changes to REScheck™ should be made which inform users that ceiling blown-in insulation R-values shall only be entered in the “Cavity” field. Currently, users must read through the REScheck™ help file to obtain the necessary information to correctly fill in this section. This could be achieved by adding a “Pop-Up” similar to the one that appears when a user enters floor insulation when basement wall insulation has been specified. The “Pop-Up” could simply state the correct practice when entering blown-in ceiling insulation. PNNL has been aware of this issue through discussions with DCEO and is hoping to make the suggested changes to the REScheck™ in the next software update.

Due to the issues of the UA Trade-off method for basement walls as discussed in Sections 4.2.2 and 5.1, it is recommended that a correction factor be applied to the UA of basement walls when determining the overall compliance of a home. This would ensure that the home is compliant in terms of code as well as energy consumption. Energy simulation models could be used to develop an interactive correction factor need to correct this issue.

ADM opted to assume that for homes in which duct and envelope leak testing was not performed, the maximum allowable leakage rate by code would be used for the energy simulation process. ADM felt that it would be biased to assume that the leakage rates for the homes in which the test were not performed to be higher than the leakage rates allowed by code. In order to quantify the energy impacts for sites in which blower door and duct blasting test were not performed, evaluators of future studies could take this upon themselves. After the completion of this study, PNNL informed us of the release of a new residential compliance methodology which places the responsibilities of performing blower door and duct blast testing on the

evaluators involved in determining compliance prior to occupancy. ADM believes this will help mitigate the availability of blower door and duct blasting results in future compliance studies, thus increasing certainty in the calculated potential energy savings for increased code compliance.

A similar methodology could also be implemented for sampled homes in which ACCA Manual J and Manual S HVAC sizing calculations were not performed. There are currently a few white papers discussing the matter. However, none of them are Illinois specific; therefore ADM opted to not include these impacts in the modeling analysis. It should be noted that PNNL's new residential compliance methodology, no longer considers ACCA sizing requirements for the determination of energy code compliance rates and typical home energy consumption.

ADM recommends that participation in DCEO offered BECP training be considered mandatory for future compliance evaluators. Evaluators would receive the same up to date training as local building professionals and be able to determine what topics are not being practiced in the field and/or lost in translation. This would allow for a continuous feedback system allowing for a constant evolution of the training program.

6. Appendix

6.1 DCEO Letter of Intent

Illinois
Department of Commerce
& Economic Opportunity
Pat Quinn, Governor

June 10, 2013

To Whom It May Concern:

The Illinois Energy Office at the Illinois Department of Commerce and Economic Opportunity administers a portfolio of energy efficiency programs called the Illinois Energy Now programs in partnership with Illinois public utilities. One of the Illinois Energy Now programs is the Building Codes Education and Technical Assistance Program. Under that program DCEO provides training to local building officials and building professionals on the current Illinois Energy Conservation Building code. The purpose is to facilitate compliance with the code and help make sure that new buildings achieve the energy efficiency called for in the code.

DCEO is required under the law to hire an independent third party to evaluate its Illinois Energy Now programs, including the Codes Program. ADM Associates and CCJM have been hired by DCEO to conduct the evaluation of the Codes Program. In order to facilitate a thorough study, DCEO asks that local building officials allow ADM and CCJM access to current new construction projects documentation. To determine the effectiveness of DCEO's codes education and training effort, ADM and CCJM plan to review approved building plans and conduct on-site verification of a sample of new buildings.

The evaluation study will help DCEO to identify areas of difficulty in energy code compliance for new construction projects within the residential and commercial sectors. The study will also estimate the energy savings of construction projects assuming all are built in compliance with the energy code. This will enable DCEO, along with Illinois utilities, to adjust its Codes Program to target particular building components, processes or audiences to improve compliance with the codes. It will also provide the foundation for measuring the improvements in compliance over time and the associated energy savings.

Thank you for your cooperation in the study. Feel free to contact me at david.s.baker@illinois.gov or 217-785-5222 if you have any questions.

Sincerely,

David S. Baker, Manager
Energy Division, Illinois Energy Office
Illinois Department of Commerce & Economic Opportunity

cc: Joshua Taylor, ADM Associates, Inc.

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6.2 Residential Compliance Form

Score + Store

Residential Data Collection Checklist
2012 International Energy Conservation Code - Residential Provisions
Climate Zone 4

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

Building Contact (optional): Name:_____ **Phone:**_____ **Email:**_____

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

Subdivision: _____ **Lot #:**_____

State:_____ **County:**_____ **Jurisdiction:**_____

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

Compliance Software Used: _____ **Above-Code Program:**_____

Building Type: 1-and 2-Family, Detached: ☐ 1-and 2-Family Dwellings ☐ Modular ☐ Townhouse
Multifamily: ☐ Apartment ☐ Condominium

Foundation Type: ☐ Basement ☐ Slab ☐ Conditioned Crawl Space ☐ Floor Over Unconditioned Space

Project Type: ☐ New Building ☐ Existing Building Addition ☐ Existing Building Renovation

2012 IECC Section #	Pre-Inspection/Plan Review	Prescriptive Code Value	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
103.1, 103.2 [PR1][1]	Construction drawings and documentation demonstrate energy code compliance for the building envelope.				☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
103.1, 103.2, 403.7 [PR3][1]	Construction drawings and documentation demonstrate energy code compliance for lighting and mechanical systems. Systems serving multiple dwelling units must demonstrate compliance with the IECC Commercial Provisions.				☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
302.1, 403.6 [PR2][2]	Heating and cooling equipment is sized per ACCA Manual S based on loads calculated per ACCA Manual J or other methods approved by the code official.		Heating: Btu/hr_____ Cooling: Btu/hr_____	Heating: Btu/hr_____ Cooling: Btu/hr_____	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	

Additional Comments/Assumptions:

10/15/2012
Version 3.0

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

Page 1 of 7

General building information only required if different than above

Building ID: _____

Date: _____ **Name of Evaluator(s):** _____

Building Contact (optional): Name: _____ **Phone:** _____ **Email:** _____

Building Name: _____ **Address:** _____ **Conditioned Floor Area:** _____ ft²

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

Compliance Software Used: _____ **Above-Code Program:** _____

2012 IECC Section #	Foundation Inspection	Prescriptive Code Value	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
402.1.1 [FO1][1]	Slab edge insulation R-value.	Unheated: R-10 Heated: R-15	R-_____ ☐ Unheated ☐ Heated	R-_____ ☐ Unheated ☐ Heated	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
303.2, 402.2.9 [FO2][1]	Slab edge insulation installed per manufacturer's instructions.			If complies: ☐ Good ☐ Fair ☐ Poor	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.1.1 [FO3][1]	Slab edge insulation depth/length.	2 ft	_____ ft	_____ ft	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.1.1 [FO4][1]	Conditioned basement wall insulation R-value. Where internal insulation is used, verification may need to occur during Insulation Inspection. Not required in warm-humid locations in Climate Zone 3.	Continuous: R-10 Cavity: R-13	R-_____ R-_____	R-_____ R-_____	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
303.2 [FO5][1]	Conditioned basement wall insulation installed per manufacturer's instructions.			If complies: ☐ Good ☐ Fair ☐ Poor	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.2.8 [FO6][1]	Conditioned basement wall insulation depth of burial or distance from top of wall.	10 ft or to basement floor	_____ ft	_____ ft	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.2.10 [FO7][1]	Unvented crawl space wall insulation R-value.	Continuous: R-10 Cavity: R-13	R-_____ R-_____	R-_____ R-_____	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
303.2 [FO8][1]	Unvented crawl space wall insulation installed per manufacturer's instructions.			If complies: ☐ Good ☐ Fair ☐ Poor	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.2.10 [FO9][1]	Unvented crawl space continuous vapor retarder installed over exposed earth, joints overlapped by 6 in. and sealed, extending at least 6 in. up and attached to the wall.				☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.2.10 [FO10][1]	Unvented crawl space wall insulation depth of burial or distance from top of wall.	To finished grade + 24 in. vertical and/or horizontal	_____ in.	_____ in.	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
303.2.1 [FO11][2]	A protective covering is installed to protect exposed exterior insulation and extends a minimum of 6 in. below grade.				☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.8 [FO12][2]	Snow- and ice-melting system controls installed.				☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	

Additional Comments/Assumptions:

General building information only required if different than above

Building ID: _____

Date: _____ **Name of Evaluator(s):** _____

Building Contact (optional): Name: _____ **Phone:** _____ **Email:** _____

Building Name: _____ **Address:** _____ **Conditioned Floor Area:** _____ ft²

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

Compliance Software Used: _____ **Above-Code Program:** _____

2012 IECC Section #	Framing / Rough-In Inspection	Prescriptive Code Value	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
402.1.1, 402.3.4 [FR1][1]	Door U-factor.	U-0.35 (24 ft² exemption)	U-_____	U-_____	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.1.1, 402.3.1, 402.3.3, 402.3.6, 402.5 [FR2][1]	Glazing U-factor (area-weighted average).	U-0.35 (15 ft² exemption)	U-_____	U-_____	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.1.1, 402.3.2, 402.3.3, 402.3.6, 402.5 [FR3][1]	Glazing SHGC value (area-weighted average).	SHGC: 0.4 (0.5 max with tradeoff; 15 ft² exemption)	SHGC:_____	SHGC:_____	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
303.1.3 [FR4][1]	U-factors of fenestration products are determined in accordance with the NFRC test procedure or taken from the default table.				☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.1.1, 402.3.3, 402.3.6, 402.5 [FR5][1]	Skylight U-factor.	U-0.55 (15 ft² exemption)	U-_____	U-_____	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.1.1, 402.3.3, 402.3.6, 402.5 [FR6][1]	Skylight SHGC value.	SHGC: 0.30 (0.5 max with tradeoff; 15 ft² exemption)	SHGC:_____	SHGC:_____	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
303.1.3 [FR7][1]	SHGC values are determined in accordance with the NFRC test procedure or taken from the default table.				☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.1.1 [FR10][1]	Mass wall exterior insulation R-value. If more than 1/2 of the insulation is on the wall interior, the interior insulation requirement applies and verification may need to occur during Insulation Inspection.	R-8 exterior R-13 interior	R-_____	R-_____	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
303.2 [FR11][1]	Mass wall exterior insulation installed per manufacturer's instructions.			If complies: ☐ Good ☐ Fair ☐ Poor	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.3.5 [FR8][1]	Fenestration in thermally isolated sunrooms has a maximum U-factor of 0.45 in Climate Zones 4-8. All other sunroom fenestration must meet code requirements.	Isolated: U-0.45 Not Isolated: U-0.35	U-_____ ☐ Isolated ☐ Not Isolated	U-_____ ☐ Isolated ☐ Not Isolated	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.3.5 [FR9][1]	Skylights in thermally isolated sunrooms have a maximum skylight U-factor of 0.70. All other sunroom skylights must meet code requirements.	Isolated: U-0.70 Not Isolated: U-0.55	U-_____ ☐ Isolated ☐ Not Isolated	U-_____ ☐ Isolated ☐ Not Isolated	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	

2012 IECC Section #	Framing / Rough-In Inspection	Prescriptive Code Value	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
402.4.1.1 [FR23][1]	Air barrier and thermal barrier installed per manufacturer's instructions.				☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.4.3 [FR20][1]	Fenestration that is not site built is listed and labeled as meeting AAMA /WDMA/CSA 101/I.S. 2/A440 or has infiltration rates per NFRC 400 that do not exceed code limits.				☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.4.4 [FR16][2]	IC-rated recessed lighting fixtures sealed at housing/interior finish and labeled to indicate <= 2.0 cfm leakage at 75 Pa.				☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.2.1 [FR12][1]	Supply ducts in attics are insulated to >=R-8. All other ducts in unconditioned spaces or outside the building envelope are insulated to >=R-6.	Attic Supply: R-8 Other: R-6	R-_____ R-_____	R-_____ R-_____	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.2.2 [FR13][1]	All joints and seams of air ducts, air handlers, and filter boxes are sealed.				☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.2.3 [FR15][3]	Building cavities are not used as ducts or plenums.				☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.3 [FR17][2]	HVAC piping conveying fluids above 105 °F or chilled fluids below 55 °F are insulated to >=R-3.	R-3	R-_____	R-_____	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.3.1 [FR24][2]	Protection of insulation on HVAC piping.				☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.4.2 [FR18][2]	Hot water pipes are insulated to >=R-3.	R-3	R-_____	R-_____	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.5 [FR19][2]	Automatic or gravity dampers are installed on all outdoor air intakes and exhausts.				☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	

Additional Comments/Assumptions:

General building information only required if different than above

Building ID: _____

Date: _____ **Name of Evaluator(s):** _____

Building Contact (optional): Name: _____ **Phone:** _____ **Email:** _____

Building Name: _____ **Address:** _____ **Conditioned Floor Area:** _____ ft²

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

Compliance Software Used: _____ **Above-Code Program:** _____

2012 IECC Section #	Insulation Inspection	Prescriptive Code Value	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
303.1 [IN13][2]	All installed insulation labeled or installed R-values provided.				☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.1.1, 402.2.6 [IN1][1]	Floor insulation R-value.	Wood: R-19 Steel: R-19+6 in 2x6; R-19+12 any	R-_____ ☐ Wood ☐ Steel	R-_____ ☐ Wood ☐ Steel	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
303.2, 402.2.7 [IN2][1]	Floor insulation installed per manufacturer's instructions, and in substantial contact with the underside of the subfloor.			If complies: ☐ Good ☐ Fair ☐ Poor	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.1.1, 402.2.5, 402.2.6 [IN3][1]	Wall insulation R-value. If this is a mass wall with at least 1/2 of the wall insulation on the wall exterior, the exterior insulation requirement applies (see FR10).	Wood: R-20 or R-13+5 Mass: R-8 exterior R-13 interior Steel: R-0+14; R-13+8.9; R-15+8.5; R-19+7.8; R-19+6.2; R-21+7.5	R-_____ ☐ Wood ☐ Mass ☐ Steel	R-_____ ☐ Wood ☐ Mass ☐ Steel	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
303.2 [IN4][1]	Wall insulation installed per manufacturer's instructions.			If complies: ☐ Good ☐ Fair ☐ Poor	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.2.12 [IN8][1]	Walls of thermally isolated sunrooms have a minimum R-value of R-13. All other sunroom walls must meet code requirements.	Thermally Isolated: R-13	R-_____ ☐ Isolated ☐ Not Isolated	R-_____ ☐ Isolated ☐ Not Isolated	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
303.2 [IN9][1]	Sunroom wall insulation installed per manufacturer's instructions.			If complies: ☐ Good ☐ Fair ☐ Poor	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.2.12 [IN10][1]	Ceilings of thermally isolated sunrooms have a minimum R-value of R-19 in Climate Zones 1-4 and R-24 in Climate Zones 5-8. All other sunroom ceilings must meet code requirements.	Thermally Isolated: R-19	R-_____ ☐ Isolated ☐ Not Isolated	R-_____ ☐ Isolated ☐ Not Isolated	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
303.2 [IN11][1]	Sunroom ceiling insulation installed per manufacturer's instructions.			If complies: ☐ Good ☐ Fair ☐ Poor	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	

Additional Comments/Assumptions:

General building information only required if different than above

Building ID: _____

Date: _____ **Name of Evaluator(s):** _____

Building Contact (optional): Name: _____ **Phone:** _____ **Email:** _____

Building Name: _____ **Address:** _____ **Conditioned Floor Area:** _____ ft²

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

Compliance Software Used: _____ **Above-Code Program:** _____

2012 IECC Section #	Final Inspection Provisions	Prescriptive Code Value	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
402.1.1, 402.2.1, 402.2.2, 402.2.6 [FI1][1]	Ceiling insulation R-value.	Wood: R-49 Steel Truss: R-38+5 Steel Joist: U-0.026 (calculations required)	R-____ ☐ Wood ☐ Steel	R-____ ☐ Wood ☐ Steel	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
303.1.1.1, 303.2 [FI2][1]	Ceiling insulation installed per manufacturer's instructions. Blown insulation marked every 300 ft².			If complies: ☐ Good ☐ Fair ☐ Poor	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.2.3 [FI22][2]	Baffle over air permeable insulation adjacent to soffit and eave vents.			If complies: ☐ Good ☐ Fair ☐ Poor	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.2.4 [FI3][1]	Attic access hatch and door insulation >=R-value of the adjacent assembly.	>=R-value of the adjacent assembly	R-____	R-____	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.4.1.2 [FI17][1]	Blower door test @ 50 Pa. <=5 ach in Climate Zones 1-2, and <=3 ach in Climate Zones 3-8.	ACH 50 <=3.0	ACH 50 = ____	ACH 50 = ____	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
402.4.2 [FI8][2]	Wood burning fireplaces have tight fitting flue dampers and outdoor air for combustion.				☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.2.2 [FI4][1]	Duct tightness test result of <=4 cfm/100 ft² across the system or <=3 cfm/100 ft² without air handler @ 25 Pa. For rough-in tests, verification may need to occur during Framing Inspection.	Across System: 4 cfm/100 ft² No Air Handler: 3 cfm/100 ft²	____ cfm/100 ft²	____ cfm/100 ft²	☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.2.2.1 [FI24][1]	Air handler leakage designated by manufacturer at <=2% of design air flow.				☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.6 [FI5][1]	Heating and cooling equipment type and capacity as per plans.				☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.1.1 [FI9][2]	Programmable thermostats installed on forced air furnaces.				☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.1.2 [FI10][2]	Heat pump thermostat installed on heat pumps.				☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.4.1 [FI11][2]	Circulating service hot water systems have automatic or accessible manual controls.				☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	

2012 IECC Section #	Final Inspection Provisions	Prescriptive Code Value	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
403.5.1 [FI25][2]	All mechanical ventilation system fans not part of tested and listed HVAC equipment meet efficacy and air flow limits.				☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.9.1 [FI12][3]	Readily accessible switch on heaters for swimming pools or permanent in-ground spas.				☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.9.2 [FI19][3]	Timer switches on heaters and pumps serving pools and permanent spas.				☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
403.9.3 [FI20][3]	Heated pools and permanent spas have a vapor retardant cover.				☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
404.1 [FI6][1]	75% of lamps in permanent fixtures or 75% of permanent fixtures have high efficacy lamps.				☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
404.1.1 [FI23][3]	Fuel gas lighting systems have no continuous pilot light.				☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
401.3 [FI7][2]	Compliance certificate posted.				☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	
303.3 [FI18][3]	Manufacturer manuals for mechanical and water heating systems have been provided.				☐ Complies ☐ Does Not Comply ☐ Not Observable ☐ Not Applicable	

Additional Comments/Assumptions: