Impact of the 2009 and 2012 International Energy Conservation Code In Multifamily Buildings

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Executive Summary

Energy conservation has become a significant priority in the multifamily industry. From designing higher performing buildings to operating more energy-efficient properties, multifamily builders, owners and operators have a vested interest in exploring new, better ways of building and managing properties.

Notably, multifamily buildings are already energy-efficient by nature. Density, shared community resources and small dwelling units offer significant energy savings over other housing types. Moreover, in typical apartment buildings, units are configured with only one exterior exposure, which minimizes air leakage and heating and cooling losses. Standard apartment construction also incorporates energy-saving building systems and products, such as high-efficiency mechanical and lighting systems.

But multifamily housing is also cost-sensitive; construction costs are carefully evaluated and pegged to predicted market revenues for completed projects. Local market conditions determine the demand for multifamily housing and set rent rates. Construction cost escalations can easily price a building out of its intended market. This is especially true for affordable projects, where rents are not as flexible as those in market-rate housing.

Building energy codes play an important role in the design and cost of multifamily buildings. The International Energy Conservation Code (IECC) is the most widely adopted of these codes, and is published by the International Code Council.

The IECC focuses on the construction of the building envelope, building insulation, efficiencies in mechanical systems and efficiencies in power systems. The code is broken into Residential and Commercial chapters, and the multifamily industry must focus on both. Multifamily buildings of three stories or less (commonly called low-rise) follow the residential provisions, while multifamily buildings of four stories or more (commonly called high-rise) fall into the commercial chapter. It also separates the country into climate zones, which provide differing requirements for building components based on geographic area.

The requirements listed in the IECC are intended to provide minimum design and construction standards. State and local jurisdictions can adopt the code in whole, in part, with amendments or adopt provisions that exceed the code minimums. New IECC editions are typically adopted several years after their publication, and each jurisdiction has its own system for code adoption, implementation and enforcement.

As such, many states have started adopting the 2009 edition of the code, which contains significant changes over the prior version – the 2006 IECC. The just-released 2012 edition, which includes even more aggressive changes and significant administrative differences, is also being vetted for adoption. As these codes evolve, code officials, designers and other building professionals are facing new equipment requirements, new rules for verification, new materials and new costs. Code professionals, developers and contractors alike, therefore, need help navigating these code changes.

In general, the code is moving toward a heavy emphasis on building insulation and building envelope construction. This report details such changes affecting building insulation values,

fenestration and air leakage. Many of these requirements have major cost impacts for apartment construction, and data suggests that such changes do not have a timely payback. For example, new insulation requirements for high-rise multifamily buildings in Climate Zone 1 – the southernmost U.S. region- will necessitate the use of more insulation as well as framing changes to accommodate the higher insulation levels. This adds several thousand dollars to the cost of each apartment unit. Moreover, based on average utility costs, the estimated energy cost savings pegged to these buildings upgrades yields a payback period of 191 to 252 years – depending on the design options selected.

In contrast, only minor changes have been incorporated for heating, ventilation and air-conditioning (HVAC) equipment and power systems. The HVAC and power systems changes can therefore often be accommodated by standard construction practices and commercially available equipment. Moreover, since these systems are largely regulated by federal appliance efficiency standards, the IECC has little impact on HVAC equipment choices. We, therefore, do not detail HVAC and power system requirements. Instead, we discuss how the changes affect how systems are sized, duct work installation, training needs and insulation requirements.

We have developed this report to help policy makers, code officials and multifamily stakeholders understand these shifts in code requirements. It provides an overview of key IECC changes for typical low- and high-rise multifamily housing. We evaluate the provisions specific to wood-framed construction; although, the requirements for steel-framed and masonry buildings have also been updated and face similar implementation challenges. In addition, numerous areas of our analysis, such as lighting and commissioning, are broadly applicable regardless of structural construction type. The report provides a detailed comparison between the 2006, 2009 and 2012 IECC editions, and includes code change explanations and cost implications for the building envelope design and various building systems installation.

This report will assist in making decisions on whether and how to incorporate new IECC changes into jurisdictional requirements and specific projects. Notably:

1. *Air Sealing* - Best practices for sealing the exterior building envelope are already addressed in the 2006 code. These cost-effective practices have been proven to save energy. However, air sealing advancements can be limited by fresh air, ventilation and moisture control needs. It is therefore important to understand the impact building sealing has on indoor air quality and the costs associated with mitigating the potential problems created by very tight building envelopes. A Blower Door Test or field inspection are two ways to verify that the envelope is well-sealed.
2. *Thermal Bridging* - Thermal bridging provides a pathway for heat transfer through the building thermal envelope. While the addition of 3/4 inch thick (R-3.8) insulation board to the building exterior will prevent thermal bridging, adding continuous insulation of higher values will not significantly add to energy savings. Any savings that can be achieved do not off-set additional construction costs required to accommodate the insulation.
3. *Insulation* - Increasing the overall R-Value or levels of the thermal insulation over the 2006 code will provide some energy performance benefits and cost savings. But, certain increases in cavity wall insulation can force changes to building framing practices. Similarly, provisions requiring the exterior insulation to exceed one-inch thickness will force changes to the building veneer systems. In these cases, energy savings will not off-set additional

construction costs. Insulation has a diminishing return and doubling the R-Value does not double building thermal efficiency.

4. *Windows and Doors* - The new fenestration performance criteria do achieve cost-effective energy savings. Products meeting the new requirements are currently available on the market, and provide a reasonable payback for most projects despite higher initial costs.
5. *HVAC* - The increased requirements for HVAC systems and lighting systems also increase energy savings. Like fenestration products, these systems are currently available on the market, and with proper planning, can be installed with minimal cost impacts.
6. *Other Building Components* – The updated 2009 and 2012 codes include requirements for a number of new building systems, verification processes and products not typically used in multifamily construction. Multifamily firms will need to dedicate time and resources to facilitate the proper implementation of these new provisions, including worker training and use of specialized, third-party consultants.

Successful building projects recognize the economic constraints of the local market, including cost burdens associated with building codes and other regulatory requirements. The offset and recapture of these costs are important considerations in determining whether a project will be developed. Here, the multifamily sector faces unique concerns. Building owners generally do not directly benefit from operational savings stemming from reduced energy usage, as building residents are typically billed for their individual utility use. Therefore, the up-front capital costs of code-required energy improvements must be recouped through other means including higher rents, the use of subsidies like tax benefits, grants or other financial incentives and, possibly, enhanced building valuation. The success of such cost recovery mechanisms has not been proven in the apartment sector.

Our analysis shows that there are considerable differences between the compliance costs for the 2009 and 2012 codes, as well as, significant cost variance between low- and high-rise multifamily buildings and across climate zones. Notably, these cost differentials are not consistent across, or between, the code editions. For instance, the changes required by the 2009 code will be most affordable for high-rise buildings in warmer climate zones – costing approximately $90 - $140 per apartment unit. In a low-rise building, however, the 2009 code changes will be most inexpensive in cooler climates – costing $230-$270 per unit. This is contrary to the impact of the 2009 changes in a high-rise building in cooler climates where cost increases range from $940 to a whopping $3,400 per unit, depending on the specific building location and design characteristics.

The costs to comply with the 2012 code are even more extreme. A low-rise building project in the two warmest climate zones (Zones 1 and 2) will be required to spend an additional $480 - $720 per apartment unit, but projects in the next two warmest zones (Zones 3 and 4) will spend a minimum of $1,820 - $2,160 more per unit. Notably, these zones encompass a significant swath of new apartment construction, extending from New Jersey to Georgia and reaching West to the Pacific coast. Conversely, high-rise buildings in these zones will cost significantly less, beginning at $340 - $900 more per unit.

The changes incorporated in the 2009 and 2012 editions of the IECC will have a considerable impact on the design, construction and affordability of multifamily buildings. In addition to direct product and labor expenses, some code changes will force structural and/or design modifications that will significantly influence typical construction practice and project costs.

Index

Definitions

Air Barrier:
A component of the building envelope that stops air leakage between conditioned (indoor) space and unconditioned (outdoor) space.

Annual Fuel Utilization Efficiency (AFUE):
A measure used to define the efficiency of a gas furnace. Higher AFUE values represent greater system efficiency.

Blower Door Test:
A design tool used to measure the air tightness of a building, and to locate sites of air leakage.

Building Thermal Envelope:
The physical, thermal break separating the interior and exterior environments of a building.

Building Envelope:
The physical, weather-proof separation between the interior and exterior environments of a building.

Continuous Insulation (ci):
Insulation that runs continuously over structural members, typically applied to the exterior side of the exterior sheathing. Applied such that there are no interruptions in the insulation, the primary function is to eliminate thermal bridging.

Climate Zones:
Developed by the U.S. Department of Energy, climate zones are represented by a map of the United States classifying regions by their climatic characteristics. The characteristics are based on data and analysis from the National Oceanic and Atmospheric Administration.

Commissioning:
The process by which building systems are documented and confirmed that they are functioning according to set criteria.

Commissioning Authority (CxA):
A certified person responsible for developing the commissioning plan, overseeing the commissioning process and confirming results.

Energy Efficiency Ratio (EER):
An efficiency measure for HVAC equipment.

Fenestration:
Opening in the building envelope, including skylights, windows and doors.

Furring:
Material strips, usually wood, attached to a wall to provide an even surface to support siding materials.

High-Efficiency Lamps:
Lamps that have a specified lumen/watt at a certain lamp wattage.

Heating, Ventilation and Air-Conditioning (HVAC):
Any system used to provide indoor environmental comfort.

Lumens:
A measure of light power emitted in a unit by a point source of one candle intensity.

Mechanical Ventilation:
A process using mechanical means to supply a building with fresh air.

Natural Ventilation:
A process using operable windows or vents to provide fresh air in a building.

On-Site Renewable Energy Systems:
Energy that is generated at the building site from non-fossil fuel sources, such as solar or wind.

Performance Path:
An alternative method of code compliance that allows whole building computer-aided energy simulation. Code compliance is based on achieving an energy savings target above the code baseline.

Prescriptive Path:
The basic path for code compliance. Code compliance is based on satisfying specific requirements dictated in the code.

R-value:
The measure of thermal resistance of a building component. The higher the R-value indicator, the higher the thermal resistance of a component (or more energy-efficient).

Seasonal Energy Efficiency Ratio (SEER):
An efficiency measure for HVAC equipment.

Solar Heat Gain Coefficient (SHGC):
The measure of how well a window blocks solar radiation. The lower the SHGC value, the more efficient the window is at blocking solar radiation.

Thermal Bridging:
A process occurring when the building thermal envelope is penetrated by a material that allows heat transmittance.

U-Factor:
A measure of heat transmission through a building component. The lower the number, the less efficient a component is at transmitting heat.

Wall Cavity Insulation:
The insulation applied in the airspace between the framing members of the exterior wall. The insulation consists of fiberglass, cellulose, mineral wool or spray foam.

Organizations / Codes:

American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE):
A professional engineer society that has developed energy standards that are referenced in the IECC.

International Code Council (ICC):
Publisher of national model building codes, known as the International Building Codes.

International Energy Conservation Code (IECC):
Part of the ICC-published family of codes, providing the energy requirement for buildings and building systems.

Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA):
A professional society of contractors that has developed standards for the installation of ductwork that are referenced in the IECC.

Introduction

Government and private sector interests alike have been looking at ways to boost energy efficiency and sustainability in real estate. Some of these efforts have focused on the use of building codes to improve the energy efficiency of buildings, resulting in the rapid development and adoption of new building energy codes nationwide. Frequently, these new codes represent a significant departure from existing design and construction practices, with new editions imposing entirely new obligations on building owners, developers, design professionals, builders and code enforcement officials.

While energy conservation is a laudable goal, it is important that policymakers and the implementers of those decisions consider the technical feasibility and cost-effectiveness of emerging building energy codes.

This report explores the major changes occurring in the nation's most widely adopted building energy code – the International Energy Conservation Code (IECC) – and their impact on the design and construction of multifamily buildings. The report further summarizes the effects of these changes and offers strategies for code compliance. It also includes side-by-side comparisons between the 2006 and 2009 editions, and the 2009 and 2012 code[1] editions.

Understanding the IECC

The IECC is part of a family of codes published by the International Code Council (ICC), which include the International Building Code, the International Mechanical Code and the International Residential Code, among others. They are developed by a national body of stakeholders (including local building officials, product manufactures, representatives of federal agencies and building industry representatives) and are designed as model codes. Although updated on a three-year cycle to reflect the latest in building science, supplements and addendum may also be issued between code editions.

As such, IECC code changes are not enforceable until they are adopted at the state or local level, and jurisdictions do not always adopt new editions as they are published. When localities do adopt an updated code edition, they will frequently issue amendments that modify the code to meet local needs. These amendments can involve deleting sections of the code, adding to the requirements or changing the reference standards for compliance.

The IECC establishes the design and construction requirements for energy use in all types of buildings, but the code lays out considerably different criteria for residential and commercial structures. Since multifamily buildings fall within the scope of both the residential and commercial provisions, apartment projects face unique challenges. Multifamily buildings three stories or less in height (hereinafter called "low-rise") must comply with the IECC's residential provisions, while multifamily buildings four stories or more (hereinafter called "high-rise") follow the code's commercial requirements. Prior to the 2012 code edition, the IECC's residential and commercial requirements were included in two chapters within the IECC – Chapter 4 (Residential Energy Efficiency) and Chapter 5 (Commercial Energy Efficiency). A significant reorganization in the 2012 version separated the IECC into two sets of provisions, Commercial and Residential, each containing

[1] The analysis provided herein is based on the pre-publication, final version of the 2012 IECC. The 2012 IECC was published as this report was going to publication.

its own chapters for scope and administration, definitions, general requirements, energy efficiency and referenced standards.

This code focuses on design and performance criteria for the building envelope, as well as, building mechanical systems (i.e. heating, ventilating and air conditioning or HVAC systems), electrical systems and lighting. The IECC also includes inspection, verification and testing procedures to ensure code compliance. However, it does not address all energy uses or specify all the energy saving features available for a building. Notably, the IECC does not regulate electronics, residential appliances or other "plug" loads, which are instead regulated by federal appliance efficiency standards and other metrics such as EPA's Energy Star Program.

The IECC is broken down into the following Chapters[2]:

- Chapter 1: Administration – Covering scope and code enforcement
- Chapter 2: Definitions
- Chapter 3: Climate Zones - Specifies nationwide climate zones used throughout the code
- Chapter 4: Residential Energy Efficiency – Provides requirements for residential buildings, including low-rise multifamily buildings three stories or less in height
- Chapter 5: Commercial Energy Efficiency – Provides requirements for commercial buildings, including high-rise multifamily buildings four stories or more in height
- Chapter 6: Reference Standards.

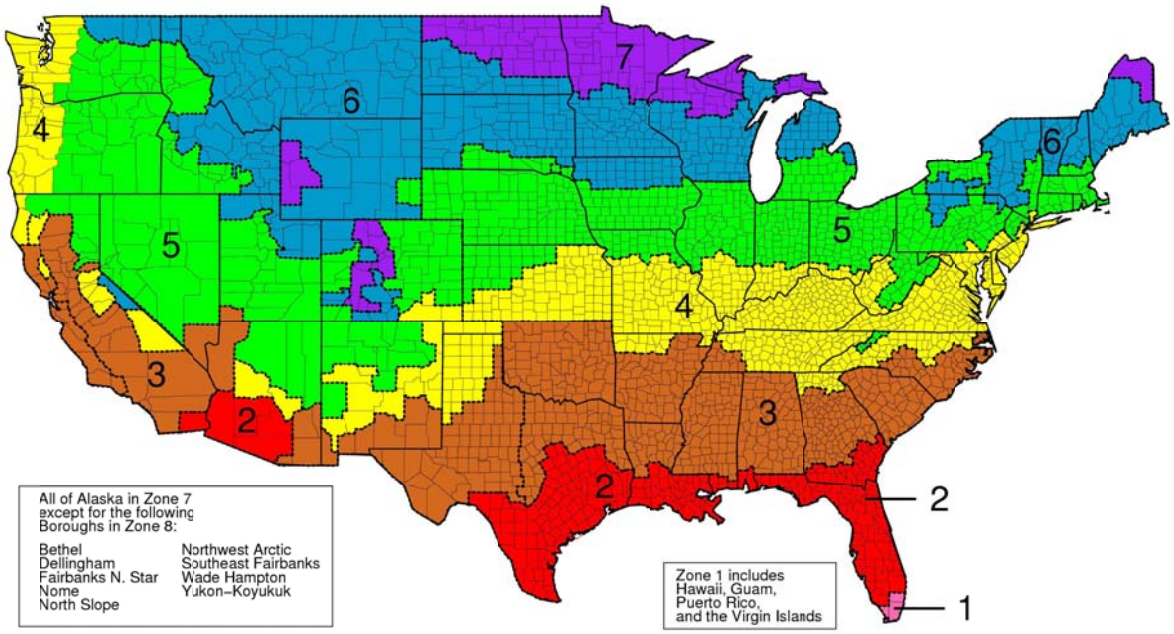
Until recently, the 2006 IECC edition was the most prevalent code in use nationwide, but many jurisdictions are now adopting the 2009 edition. And, even though fewer than 30 states have adopted the 2009 (or equivalent) code to date[3], some states and municipalities are already vetting the 2012 version. This poses significant challenges for the real estate sector, as the 2009 IECC includes substantial changes over previous versions and the 2012 edition incorporates even more exacting standards.

To allow the IECC to provide compliance criteria across a wide range of geographic and climatic regions, the code references the U.S. Department of Energy's climate zone map. The map breaks the United States into eight climate zones, which are based on typical heating and cooling requirements. The map also considers humidity levels, dry climates, wet conditions and marine environments. Code application is based on a building's location within a climate zone.

[2] New formatting in the 2012 IECC reorganizes and renames some chapters, and establishes two sets of code provisions: Commercial and Residential. However, the content and scope of the code chapters are largely unchanged.

[3] See the U.S. Department of Energy's "Status of All State Energy Codes", http://www.energycodes.gov/states/state_status_full.php.

U.S. Climate Zone Map



Section B - Code Change Commentary

As localities review their building codes and multifamily firms update and design new properties, they find themselves with a host of potential changes to consider. This commentary outlines the most significant changes for multifamily structures between the IECC's 2006, 2009 and 2012 editions for the following building components and performance requirements:

- Building envelope;
- Building insulation systems;
- Building fenestration systems;
- Mechanical systems;
- Electrical systems;
- Simulated performance alternatives;
- Daylight zones;
- Lighting controls;
- Additional energy performance; and
- Building commissioning.

This commentary also provides information about the potential financial, operational and architectural impacts of these code changes. Our cost calculations derive from the Engineering News-Record Square Foot Costbook 2010, along with real-world estimates, and represent the per-apartment unit cost in today's dollars of complying with new code requirements. The 2006 IECC served as the baseline for the 2009 cost estimates (i.e. the estimates show the expected cost increases over the 2006 code), while the 2012 estimates show costs compared to the 2009 code. Therefore, where the 2009 code has not been adopted, total 2012 compliance costs will be higher than those indicated here. These costs are typical of a medium market; some multifamily properties may see lower or higher costs, depending on their specific location. This data is based on a subcontractor's cost for material, labor and taxes. General contractor overhead and fees are not included in this Section's cost estimates until Chapter B.10 – Cost Summary.

Using those assumptions, we have calculated costs based on two representative multifamily properties**:**

- A low-rise, multifamily building: This property is a 27-unit, three-story building with a floor plate of 10,174 square feet per floor. It has nine units per floor and enclosed corridors.
- A high-rise, multifamily building: This property is a 36-unit, four-story building with a floor plate of 10,174 square feet per floor. It also has nine units per floor and enclosed corridors.

A more detailed description of these buildings and the cost analysis can be found in Section B.10 - Cost Summary.

Section B.1 – Building Envelope

Recent editions of the IECC have paid particular attention to the building envelope and the issue of air leakage, which is a well-established cause of energy inefficiency in buildings.

The building envelope commonly refers to those components that separate a building's indoor space from the outdoors. According to the IECC, the "envelope" includes a property's basement walls, exterior walls, floor, roof and any other building element that encloses "conditioned space," which is any area within the property that is heated or cooled or contains uninsulated ductwork.

A well-designed building envelope minimizes air leakage between the conditioned and unconditioned spaces, which results in more efficient heating and cooling, lower utility costs and improved comfort for residents. In contrast, a building with poorly designed or incorrectly installed envelope components allows excessive amounts of air to move into or out of a conditioned space, making heating and cooling systems work harder with less effective results. This extra load on the heating and cooling systems can also reduce the life span of the equipment, increasing the maintenance costs of the building. Further, uncontrolled air leakage can introduce moisture into the building assembly, raising mold and indoor air quality concerns.

Common causes of air leakage include gaps around windows, doors, vents and other building envelope penetrations, such as exterior lighting. Sealing these openings, and the use of properly placed air barriers (such as housewrap), can effectively reduce the energy losses and other problems associated with air leakage.

Generally, the building's waterproof barrier (i.e. housewrap) also acts as the air barrier in both low- and high-rise multifamily buildings. The preferred air barrier is a spunbonded olefin, non-woven, non-perforated product. All seams and penetrations are required to be sealed. Continuous ridge insulation can be substituted as the waterproof barrier and air barrier; however, fenestrations and penetrations are more difficult to seal with this system.

In addition to sealing around windows, doors and vents, the code lists additional locations that require sealing. These include:

- utility penetrations, ceiling and chases adjacent to the thermal envelope;
- knee walls, walls and ceilings separating unconditioned spaces;
- behind bath tubs on exterior walls;
- common walls between dwelling units; and
- numerous other locations (See Appendix A.3, Images A.3.2 (Envelope Sealing Details)).

The 2006 IECC addresses air leakage by requiring that specific areas of the building envelope be sealed using caulk, weather stripping or other materials, including use of an air barrier material.

Changes: 2009

The 2009 IECC introduces a verification provision that requires low-rise multifamily buildings to demonstrate that the air sealing and insulation measures comply with the code's requirements. Verification requires either a visual inspection by a trained professional or a blower door test. High-rise multifamily buildings are only required to have an air barrier, with no specific requirements for inspection and testing.

Changes: 2012

The 2012 IECC boosts the requirements for multifamily building envelopes and establishes specifics for allowable air leakage in apartment buildings. However, the requirements and test methods for low-rise buildings differ from those for high-rise buildings.

Low-rise multifamily buildings must have an air barrier, which must be blower-door tested to determine compliance (eliminating the visual inspection option available in the 2009 code). To comply, such buildings in zones 1 and 2 must have an air leakage of fewer than five air changes per hour and those in zones 3-8 must have an air leakage of less than three air changes per hour, at a blower door pressure of 0.2 inches w.g. (50 Pa).

High-rise buildings in zones 4-8 are also required to have an air barrier (note that high-rise buildings in zones 1-3 are exempt). The code provides three options for satisfying the air barrier requirements: 1) the envelope must be constructed of materials with air permeability no greater than 0.004 cubic feet per minute (cfm)/feet^2

under a pressure differential of 75 Pa; 2) assemblies of materials are used with an average air leakage not to exceed 0.04 cfm/feet^2 under a pressure differential of 75 Pa; or 3) the completed building is blower door-tested and air leakage does not exceed 0.40 cfm/feet^2 at a pressure differential of 75 Pa.

Blower Door Tests

As discussed above, a blower door test is a diagnostic tool that measures air leakage through the building envelope. (See Image A.3.1, Appendix A.3). For multifamily projects, blower door testing is usually based on a sampling rate of a certain proportion of units at a property. However, this sampling rate can vary by jurisdiction, so developers must consult the local code authority for specific test requirements prior to testing.

In the 2012 IECC, the blower door test is a required, critical building component test for low-rise multifamily buildings. The blower door test remains an optional compliance path for high-rise buildings. To facilitate compliance with the air leakage requirements, subcontractors responsible for the envelope should be trained on the installation of the envelope components. Pre-drywall, pre-veneer inspection and post-drywall inspection are also recommended prior to the blower door test. Failure of the test could require disassembly and reconstruction of parts of the envelope. The noted training and inspections can help minimize test failures.

It is important to note that the blower door test protocol is based on the single-family residential market. The test procedures are based on Residential Engineering Services Network (Resnet) protocol and ASHRAE Standard 119. While the test procedure is used in multifamily buildings, standards are lacking that dictate either whole building testing or unit testing. Prior to undertaking blower door testing in a multifamily building, the local code authority should be consulted to determine the testing procedure.

Estimated additional cost per unit:

- $150 to $170 for a visual inspection.
- $300 to $350 for the blower door test.

B.2 – Building Insulation

Exterior Wall Insulation

Climate, as determined by the U.S. Department of Energy Climate Zone Map, significantly affects IECC requirements for a multifamily building's exterior envelope. From South Florida (Zone 1) to Alaska (Zone 8), each zone has different requirements for the components that make up the building's envelope assembly.

Within multifamily construction, the major items of concern include the requirements for:

- fenestration (windows and doors);
- ceiling/attic insulation;
- wall cavity insulation;
- continuous exterior insulation; and
- foundation insulation.

New requirements in the 2009 and 2012 editions increase the R-values (or insulation efficiency levels) for wall cavity insulation and continuous insulation, causing a series of practical and financial considerations. The thickness of high R-value insulation products can impact the design and construction of building wall cavities. As the building insulation's R-value increases, stud depth must increase, which may force changes in building

framing practices. Low-rise multifamily structures, as well as many high-rise apartment buildings, are typically built with 2x4 inch framing members. The 3.5 inch deep stud wall created by 2X4 framing can only accommodate cavity wall insulation of R-13 or R-15 at maximum. To accommodate the thicker insulation (ex. R-20), required in the new code editions, the cavity depth will need to increase to 5.5 inches.

This necessitates a change from 2x4 framing to 2x6 framing, which can affect the project's cost, structural members and other building features. The larger stud size will reduce the property's conditioned (and usable) square footage by two inches around the perimeter of the building. Since rent rates and property sale prices are usually based on conditioned square footage, this change can negatively impact building valuation.

Further, the increase in the R-value for continuous insulation will affect how exterior veneer systems are fastened to the building's sheathing. When the exterior insulation exceeds one inch in thickness, conventional fastening methods are no longer able to be used and alternative fastening for these systems is significantly more expensive.

In addition to fastening issues, the goal of making the building watertight and weather-tight around windows and doors will be difficult. Most window and door manufacturers have products with thin profiles that will not accommodate the dimensions of this thicker insulation. This requires the use of additional trim pieces around windows and doors.

The increased wall thickness associated with increased insulation levels may also impact accessibility requirements and force building design changes. The Americans with Disabilities Act (ADA) and the Fair Housing Accessibility Guidelines (FHAG) both demand that certain minimum dimensions be maintained in apartment buildings and individual dwelling units, including provisions addressing door sizes and essential rooms, such as kitchens and bathrooms. Where interior space is lost to larger wall cavities, apartment units may need to be reconfigured.

These changes are summarized below, with new requirements detailed for each climate zone and multifamily building type.

Zone 1:

LOW-RISE MULTIFAMILY. No changes.

HIGH-RISE MULTIFAMILY.

Changes: 2009

The required R-value for ceiling/attic insulation increases from R-30 to R-38. The change will increase the thickness of the ceiling insulation from 10.25 inches to 12.75 inches.

Changes: 2012

The required R-value for ceiling/attic insulation does not increase over 2009 levels. Wall-cavity insulation increases from R-13 under the 2006 and 2009 codes, to either R-13 wall cavity insulation with R-3.8 continuous insulation (ci) or to R-20 wall cavity insulation.

The typical framing size for this building type is 2x4 studs, which must increase to 2x6 stud framing to accommodate the 5.5-inch thickness of the required R-20 batt insulation. The R-3.8 continuous insulation for the wall cavity will require a 0.75" minimum rigid insulation board applied to the exterior of the building envelope.

Estimated additional cost per unit:

- $71 to $99 for the two additional inches of blown-in insulation to increase R-values for the ceiling/attic insulation.
- $737 to $872 for R-13 insulation with R-3.8 continuous insulation.
- $1,140 to $1,307 for R-20 wall cavity insulation with 2x6 framing.

Summary Chart: Zone 1 Changes

Zone 1	Chapter 4 Low-Rise Multifamily			Chapter 5 High-Rise Multifamily		
	IECC 2006	IECC 2009	IECC 2012	IECC 2006	IECC 2009	IECC 2012
Ceiling/Attic R-value[2]	R-30	R-30	R-30	R-30	R-38	R-38
Wood Frame Wall R-value[1,2]	R-13	R-13	R-13	R-13	R-13	R-13+R-3.8ci or R-20
Unheated Slab R-value and Depth	NR	NR	NR	NR	NR	NR

1. Code has equivalent R-values for steel frame construction.
2. As an alternate to building to the R-values listed the code accepts the U-factor for the assembly.

Zone 2:

LOW-RISE MULTIFAMILY.

Changes: 2009

No changes.

Changes: 2012

The ceiling/attic R-value increases from R-30 in the 2006 and 2009 versions to R-38 in 2012. For most multifamily projects, blown-in insulation is the typical application for attic insulation**.** The change will increase the thickness of the ceiling insulation from 10.25 inches to 12.75 inches.

Estimated additional cost per unit: $94 to $132.

HIGH-RISE MULTIFAMILY.

Changes: 2009

The ceiling/attic insulation R-value increases from R-30 in 2006 to R-38 in 2009.

Changes: 2012

The wall insulation R-value changes from a single requirement (R-13 in both the 2006 and 2009 codes) to a choice of installing either R-20 wall cavity insulation or R-13 wall cavity insulation with R-3.8 continuous insulation.

Estimated additional costs per unit for various new code requirements:

- $71 to $99 for the two additional inches of blown-in insulation to increase R-values for the ceiling/attic insulation.
- $737 to $872 for R-13 insulation with R-3.8 continuous insulation.
- $1,140 to $1,307 for R-20 wall cavity insulation with 2x6 framing.

Summary Chart: Zone 2 Changes

Zone 2	Chapter 4 Low-Rise Multifamily			Chapter 5 High-Rise Multifamily		
	IECC 2006	IECC 2009	IECC 2012	IECC 2006	IECC 2009	IECC 2012
Frame Ceiling R-value[2]	R-30	R-30	R-38	R-30	R-38	R-38
Wood Frame Wall R-value[1,2]	R-13	R-13	R-13	R-13	R-13	R-13+R-3.8ci or R-20
Unheated Slab R-value and Depth	NR	NR	NR	NR	NR	NR

1. Code has equivalent R-values for steel frame construction.
2. As an alternate to building to the R-values listed the code accepts the U-factor for the assembly.

Zone 3:

LOW-RISE MULTIFAMILY.

Changes: 2009

No changes.

Changes: 2012

The ceiling/attic insulation increases to R-38 from R-30 and wall cavity insulation increases from R-13 (2006 and 2009) to the choice of either R-20 insulation or R-13 insulation with R-5 continuous insulation. This represents a significant increase in wall cavity insulation that will impact other aspects of building design and construction.

R-5 continuous insulation is typically 1" rigid insulation board, which would have a significant impact on a building's veneer systems. For example, buildings with lap siding will require furring to provide an anchoring location for the siding, and additional accessories will be required to close gaps around doors and windows. (See Appendix A.3, Details A.3.3 through A.3.6). Buildings with brick veneer would need to widen the cavity to accommodate the increased insulation thickness. This will force an expansion of the foundation brick shelf to properly support the brick (See Appendix A.3, Details A.3.7 and A.3.8).

The other option, R-20 insulation, will require a change in stud size from 2x4 framing to 2x6 framing to accommodate the 5.5-inch thickness of the insulation.

Estimated additional costs per unit for various new code requirements:

- $94 to $132 for R-38 insulation in the ceiling/attic.
- $1,124 to 1,290 for R-20 wall cavity insulation and 2x6 framing.
- $1,984 to $2,315 for R-5 continuous insulation on lap-sided buildings.
- $1,371 to $1,637 for R-5 continuous insulation on brick veneer buildings.

HIGH-RISE MULTIFAMILY.

Changes: 2009

Ceiling and attic insulation levels increase from R-30 to R-38.

Changes: 2012

The 2012 code allows for wall cavity insulation of either R-20 or R-13 with R-3.8 continuous insulation. (R-3.8 is typically 0.75-inch rigid insulation board.) The higher levels of R-38 attic/ceiling insulation from the 2009 edition are also carried over.

Estimated additional costs per unit for various new code requirements:

- $71 to $99 for the two additional inches of blown-in insulation to increase R-values for the ceiling/attic insulation.
- $737 to $872 for R-13 insulation with R-3.8 continuous insulation.
- $1,140 to $1,307 for R-20 wall cavity insulation with 2x6 framing.

Summary Chart: Zone 3 Changes

Zone 3	Chapter 4 Low-Rise Multifamily			Chapter 5 High-Rise Multifamily		
	IECC 2006	IECC 2009	IECC 2012	IECC 2006	IECC 2009	IECC 2012
Ceiling/Attic R-value[2]	R-30	R-30	R-38	R-30	R-38	R-38
Wood Frame Wall R-value[1,2]	R-13	R-13	R-13+ R-5ci or R-20	R-13	R-13	R-13+R-3.8ci or R-20
Unheated Slab R-value and Depth	NR	NR	NR	NR	NR	NR

1. Code has equivalent R-values for steel frame construction.
2. As an alternate to building to the R-values listed the code accepts the U-factor for the assembly.

Zone 4 (Not Marine)

LOW-RISE MULTIFAMILY.

Changes: 2009

No changes.

Changes: 2012

Wall cavity insulation increases from R-13 in 2006 and 2009 to a choice between R-20 wall cavity insulation or R-13 with R-5 continuous insulation (see R-5 discussion in Zone 3).

The ceiling/attic insulation requirement jumps from R-38 in 2006 and 2009 to R-49 in the 2012 code. This represents a change in insulation depth from 12.75 inches to 16.25 inches, which will markedly impact the weight on the ceiling systems. Multifamily architects, designers and builders will need to work with drywall manufacturers to find fastening methods that will adequately handle the increased load.

Estimated additional costs per unit for various new code requirements:

- $132 to $170 for additional attic/ceiling insulation plus the cost for additional support.
- $1,371 to $1,637 for R-5 continuous insulation on brick veneer buildings.
- $1,984 to $2,315 for R-5 continuous insulation on lap-sided buildings.
- $1,124 to $1,290 for R-20 wall cavity insulation with 2x6 framing.

HIGH-RISE MULTIFAMILY.

Changes: 2009

Ceiling and attic insulation increases from R-30 in 2006 to R-38 in 2009, while the requirements for wall cavity insulation increase from R-13 in 2006 to R-13 with R-3.8 continuous insulation in 2009. In addition, a new requirement for under-slab insulation is added in 2009. R-10 rigid insulation is required to extend 2 feet down or under the slab.

Changes: 2012

Like other zones, the 2012 code will allow the choice of R-20 wall cavity insulation or R-13 wall cavity insulation with R-3.8 continuous insulation. The higher levels of R-38 attic/ceiling insulation and the R-10, 2 feet under-slab insulation requirement from the 2009 edition are also carried over.

Estimated additional costs per unit for various new code requirements:

- $29 to $31 for slab insulation.
- $71 to $99 for R-38 ceiling/attic insulation in 2009.
- $737 to $872 for R-13 insulation with R-3.8 continuous insulation.
- $1,140 to $1,307 for R-20 wall cavity insulation with 2x6 framing.

Summary Chart: Zone 4 (Not Marine) Changes

Zone 4 (Not Marine)	Chapter 4 Low-Rise Multifamily			Chapter 5 High-Rise Multifamily		
	IECC 2006	IECC 2009	IECC 2012	IECC 2006	IECC 2009	IECC 2012
Ceiling/Attic R-value[2]	R-38	R-38	R-49	R-30	R-38	R-38
Wood Frame Wall R-value[1,2]	R-13	R-13	R-13 +R-5ci or R-20	R-13	R-13+R-3.8ci	R-13+3.8ci or R-20
Unheated Slab R-value and Depth	R-10, 2 ft	R-10, 2 ft	R-10, 2 ft	NR	R-10, 2 ft	R-10, 2 ft

1. Code has equivalent R-values for steel frame construction.
2. As an alternate to building to the R-values listed the code accepts the U-factor for the assembly.

Zone 5 and Zone 4 (Marine)

LOW-RISE MULTIFAMILY.

Changes: 2009

In this climate, the ceiling/attic insulation requirement does not change between 2006 and 2009, but slightly different wall cavity insulation levels are required. In both 2006 and 2009, buildings can satisfy the code requirements by incorporating R-13 wall cavity insulation with R-5 continuous insulation[4]. In 2006, buildings also have the alternative compliance option of installing R-19 wall cavity insulation. In 2009, the alternative compliance increases to R-20.

Changes: 2012

The same increase in wall cavity insulation is carried over to the 2012 code, while ceiling and attic insulation levels rise to R-49 from R-38.

Estimated additional costs per unit for various new code requirements:

- $132 to $170 for ceiling/attic insulation.

HIGH-RISE MULTIFAMILY.

Changes: 2009

The 2006 code requires wall cavity insulation of R-13, but the 2009 edition boosts the insulation requirements in ways that will require adjustments in the building's construction. The 2009 code maintains the R-13 wall cavity insulation, but adds a requirement for continuous insulation of R-3.8. This is typically 0.75-inch rigid insulation board. The ceiling/attic insulation requirements also increase to R-38 from R-30, and R-10 rigid insulation is required to extend 2 feet down or under the slab.

[4] Note that the 2009 code specifies R-13 wall cavity insulation plus R-5 "insulated sheathing." Insulated sheathing (is) is an example of continuous insulation.

Changes: 2012

In the 2012 code, designers may choose to install R-13 wall cavity insulation with R-7.5 continuous insulation or use R-20 wall cavity insulation with R-3.8 continuous insulation. Note that R-7.5 continuous insulation is typically 1.5-inch-thick rigid insulation board. Further, the ceiling/attic insulation requirements increase again from R-38 in 2009 to R-49 in 2012.

The increased thickness of the insulation board —1.5 inches—is likely to cause problems with veneer, door and window systems used in multifamily projects.

- Lap siding, as noted for the application on R-5 insulation (see Zone 3), will require furring strips to provide a proper fastening surface. (See Images A.3.3 to A.3.4, Appendix A.3)
- Doors and windows typically do not have the trim depth to cover the 1.5-inch gap. This means that additional trim pieces must be installed to properly weather-proof the building envelope. (See Images A.3.5 to A.3.8, Appendix A.3).
- For masonry veneer buildings, the support conditions will need to change. The foundation brick shelf must be extended, as noted previously for the R-5 insulation. As a result, the lintel angles at openings will increase from a standard 5”x 5”x3/8” steel angle to a 5”x 6”x3/8” bent plate to accommodate the new cavity depth required for the additional insulation. (See Images A.3.7 and A.3.8, Appendix A.3).

Estimated additional costs per unit for various new code requirements:

- $29 to $31 for slab insulation.
- $71 to $99 for the ceiling/attic insulation (2009); and $132 to $170 for ceiling/attic insulation in the next code edition (2012)
- $737 to $872 for R-13 insulation with R-3.8 continuous insulation.
- $1,609 to $1,877 for R-13 cavity insulation with R-7.5 continuous insulation for buildings with lap siding.
- $1,119 to $1,335 for R-13 cavity insulation with R-7.5 continuous insulation for brick buildings.
- $1,877 to $2,179 for R-20 cavity insulation and R-3.8 continuous insulation.

Summary Chart: Zone 5 and Zone 4 (Marine) Changes

Zone 5; Zone 4 (Marine)	**Chapter 4 Low-Rise Multifamily**			**Chapter 5 High-Rise Multifamily**		
	IECC 2006	IECC 2009	IECC 2012	IECC 2006	IECC 2009	IECC 2012
Ceiling/Attic R-value	R-38	R-38	R-49	R-30	R-38	R-49
Wood Frame Wall R-value[1,2]	R-13+R-5is or R-19	R-13+ R-5is or R-20	R-13+ R-5ci or R-20	R-13	R-13+R-3.8ci	R-13+R-7.5ci or R-20+R-3.8ci
Unheated Slab R-value and Depth	R-10, 2 ft	R-10, 2 ft	R-10, 2 ft	NR	R-10, 2 ft	R-10, 2 ft

1. Code has equivalent R-values for steel frame construction.
2. As an alternate to building to the R-values listed the code accepts the U-factor for the assembly.

Zone 6

LOW-RISE MULTIFAMILY.

Changes: 2009

There are no changes in ceiling and attic insulation levels, but wall cavity insulation increases to R-20 or R-13 plus R-5 continuous insulation[5] from R-19 or R-13 plus R-5 ci.

Changes: 2012

There are no changes in ceiling and attic insulation levels, but wall cavity insulation increases to R-20+R-5 continuous insulation or R-13 plus R-10 continuous insulation.

R-10 continuous insulation is typically two-inch thick, rigid insulation, which creates the same support issues previously noted for R-5 insulation with lap siding and for R-7.5 insulation with brick veneers (see discussion in Zones 3 and 5).

Estimated cost per unit:

- There is no cost impact for the change in wall cavity insulation from R-19 to R-20.
- $1,984 to $2,248 to accommodate the R-10 increase in insulation for a building with lap siding.
- $1,440 to $1,646 to accommodate the R-10 increase in insulation for a building with brick veneers.
- $1,984 to $2,315 for R-20 cavity insulation with R-5 continuous insulation with lap siding veneer
- $1,371 to $1,637 for R-20 cavity insulation with R-5 continuous insulation with brick veneer.

HIGH-RISE MULTIFAMILY.

Changes: 2009

The ceiling/attic insulation increases from R-30 in 2006 to R-38 in 2009. Similar to other zones, wall cavity insulation requirements increase from R-13 in 2006 to R-13 wall cavity insulation with R-7.5 continuous insulation. In addition, the under slab insulation changes from no requirements in 2006 to R-15 insulation that extends two feet down or under from the face of slab in 2009.

Changes: 2012

In the 2012 code, designers may choose to install R-13 wall cavity insulation with R-7.5 continuous insulation or use R-20 wall cavity insulation with R-3.8 continuous insulation. Further, the ceiling/attic insulation requirements increase again from R-38 in 2009 to R-49 in 2012. Finally, new under slab insulation requirements carry over from the 2009 edition.

See discussion of problems arising from R-7.5 continuous insulation in the Zone 6 low-rise section.

Estimated additional costs per unit for various new code requirements:

- $59 to $62 for the slab insulation.
- $71 to $99 for the ceiling/attic insulation (2009 edition); and $99 to $127 for ceiling/attic insulation (2012 edition)
- $2,346 to $2,749 for R-13 cavity insulation with R-7.5 continuous insulation for buildings with lap siding.
- $1,856 to $2,207 for R-13 cavity insulation with R-7.5 continuous insulation for brick buildings.

[5] Note that the 2009 code specifies R-13 wall cavity insulation plus R-5 "insulated sheathing." Insulated sheathing (is) is an example of continuous insulation.

- $1,877 to $2,179 for R-20 cavity insulation and R-3.8 continuous insulation for a lap siding veneer or a brick veneer building.

Summary Chart: Zone 6 Changes

Zone 6	Chapter 4 Low-Rise Multifamily			Chapter 5 High-Rise Multifamily		
	IECC 2006	IECC 2009	IECC 2012	IECC 2006	IECC 2009	IECC 2012
Ceiling/Attic R-value	R-49	R-49	R-49	R-30	R-38	R-49
Wood Frame Wall R-value[1,2]	R-13 + R-5is or R-19	R-13+ R-5is or R-20	R-13+ R-10ci or R-20+R-5	R-13	R-13+R-7.5ci	R-13+R-7.5ci or R-20+R-3.8ci
Unheated Slab R-value and Depth	R-10, 4 ft	R-10, 4 ft	R-10, 4 ft	NR	R-15, 2 ft	R-15, 2 ft

1. Code has equivalent R-values for steel frame construction.
2. As an alternate to building to the R-values listed the code accepts the U-factor for the assembly.

Zone 7

LOW-RISE MULTIFAMILY.

Changes: 2009

No changes, except that floor insulation increases to R-38 from R-30.[6]

Changes: 2012

Wall cavity insulation levels changes to R-20 with R-5 continuous insulation (see R-5 discussion in Zone 3 and 5) or R-13 with R-10 continuous insulation. The R-13 cavity insulation with R-10 continuous insulation option will allow builders to use 2x4 framing instead of 2x6 framing, reducing the cost impact of the increased insulation.

Estimated additional costs per unit for various new code requirements:

- $1,984 to $2,315 to add R-5 continuous insulation for a lap siding building.
- $1,371 to $1,637 to add R-5 continuous insulation for a brick building.
- $1,719 to $2,017 to use R-13 cavity insulation with R-10 continuous insulation and 2x4 framing for a lap siding building. This includes a deduction for reducing the framing from 2x6 studs to 2x4 studs, and reducing the insulation from R-20 to R-13.
- $1,176 to $1,414 to use R-13 cavity insulation with R-10 continuous insulation and 2x4 framing for a brick veneer building. This includes a deduction for reducing the framing from 2x6 studs to 2x4 studs, and reducing the insulation from R-20 to R-13.

[6] Floor insulation values were not discussed in other zones, since changes to floor R-values only appear in Zones 7 and 8. You will note that costs are not identified for these changes. This stems from the fact that the amount of floor insulation is based on individual building design characteristics, and the code requires buildings to install R-38 or insulation sufficient to fill the framing cavity with a minimum of R-19.

HIGH-RISE MULTIFAMILY.

Changes: 2009
Requirements for ceiling/attic insulation do not change from the 2006 code, but wall cavity insulation levels increase to R-13 plus R-7.5 continuous insulation. The new code also requires under-slab insulation of R-15, extending two feet down or under from the slab edge.

Changes: 2012
Ceiling and attic insulation levels increase from R-38 in 2006 and 2009 to R-49 in 2012. Wall cavity insulation levels further increase to require either R-13 wall cavity insulation with R-7.5 continuous insulation or R-20 with R-3.8 continuous insulation.

Estimated additional costs per unit for various new code requirements:

- $99 to $127 for ceiling/attic insulation.
- $2,346 to $2,749 for R-13 cavity insulation with R-7.5 continuous insulation for buildings with lap siding.
- $1,856 to $2,207 for R-13 cavity insulation with R-7.5 continuous insulation for brick buildings.
- $59 to $62 to add R-15 under-slab insulation.
- $1,877 to $2,179 for adding R-3.8 continuous insulation with R-20 cavity insulation.

Summary Chart: Zone 7 Changes

Zone 7	Chapter 4 Low-Rise Multifamily			Chapter 5 High-Rise Multifamily		
	IECC 2006	IECC 2009	IECC 2012	IECC 2006	IECC 2009	IECC 2012
Ceiling/Attic R-value	R-49	R-49	R-49	R-38	R-38	R-49
Wood Frame Wall R-value[1,2]	R-21	R-21	R-13+ R-10ci or R-20+R-5ci	R-13	R-13+R-7.5ci	R-13+R-7.5ci or R-20+R-3.8ci
Unheated Slab R-value and Depth	R-10, 4 ft	R-10, 4 ft	R-10, 4 ft	NR	R-15, 2 ft	R-15, 2 ft

1. Code has equivalent R-values for steel frame construction.
2. As an alternate to building to the R-values listed the code accepts the U-factor for the assembly.

Zone 8

LOW-RISE MULTIFAMILY.

Changes: 2009
No changes, except that floor insulation increases to R-38 from R-30[7].

[7] See Note 6 above.

Changes: 2012
Requirements for ceiling/attic insulation do not change from the 2006 code, but wall cavity insulation level changes from R-21 to R-20 plus R-5 continuous insulation or R-13 with R-10 continuous insulation. The new R-13 cavity insulation option will allow builders to use 2x4 framing instead of 2x6 framing, reducing the cost impact of the increased insulation. Increases in floor insulation also carry over from the 2009 code.

Estimated additional costs per unit for various upgrades:

- $1,984 to $2,315 to add R-5 continuous insulation for a lap siding building.
- $1,371 to $1,637 to add R-5 continuous insulation for a brick building.
- $1,719 to $2,017 to use R-13 cavity insulation with R-10 continuous insulation and 2x4 framing for a lap siding building. This includes a deduction for reducing the framing from 2x6 studs to 2x4 studs, and reducing the insulation from R-20 to R-13.
- $1,176 to $1,414 to use R-13 cavity insulation with R-10 continuous insulation and 2x4 framing for a brick veneer building. This includes a deduction for reducing the framing from 2x6 studs to 2x4 studs, and reducing the insulation from R-20 to R-13.

HIGH-RISE MULTIFAMILY.

Changes: 2009
Wall cavity insulation increases to R-13 insulation with R-15.6 continuous insulation. Requirements for ceiling/attic insulation also increase from R-38 in 2006 to R-49 in 2009. The under-slab insulation also increases to R-20, extended two feet from the slab edge.

Changes: 2012
No changes from the 2009 code, except another wall insulation option is provided, allowing for R-13 wall cavity insulation with R-15.6 continuous insulation or R-20 wall cavity insulation with R-10 continuous insulation.

Estimated additional costs per unit for various upgrades:

- $2,561 to $2,749 for R-15.6 continuous insulation on a building with lap siding.
- $2,029 to $2,177 for R-15.6 continuous insulation on a brick building.
- $4,170 to $4,793 for R-20 wall cavity insulation with R-10 continuous insulation on a building with lap siding.
- $3,601 to $4,185 for R-20 wall cavity insulation with R-10 continuous insulation on a building with brick veneer.
- $59 to $61 to add R-20 under-slab insulation.
- $99 to $127 to increase the attic insulation to R-49.

Summary Chart: Zone 8 Changes

Zone 8	Chapter 4 Low-Rise Multifamily			Chapter 5 High-Rise Multifamily		
	IECC 2006	IECC 2009	IECC 2012	IECC 2006	IECC 2009	IECC 2012
Ceiling /Attic R-value	R-49	R-49	R-49	R-38	R-49	R-49

Wood Frame Wall R-value[1,2]	R-21	R-21	R-13+R-10ci or R-20+R-5ci	R-13 + R-7.5ci	R-13 + R-15.6ci	R-13 + R-15.6ci or R-20 + R-10ci
Unheated Slab R-value and Depth	R-10, 4 ft	R-10, 4 ft	R-10, 4 ft	R-10, 2 ft	R-20, 2 ft	R-20, 2 ft

1. Code has equivalent R-values for steel frame construction.
2. As an alternate to building to the R-values listed the code accepts the U-factor for the assembly.

B.3 – Fenestrations

The window and door systems needed to comply with 2009 and 2012 code requirements necessitate the use of products not typically used in most multifamily projects. The latest code changes require that doors be insulated and windows have a low-e coating to mitigate energy loss. In northern climate zones, windows must be argon-gas-filled. These products are currently available on the market, but carry a cost premium.

LOW-RISE MULTIFAMILY

Changes: 2009

Zone 1 – No U-factor changes, but solar heat gain coefficient (SHGC) values increase the glazing performance from .40 to .30. Depending on the manufacturer, glazing systems with a solar heat gain coefficient of .30 are typically insulated windows with a low-e coating.
Zone 2 - U-factor changes from .75 in 2006 to .65 in 2009. SHGC values increase the glazing performance from .40 to .30.
Zone 3 - U-factor changes from .65 to .50 in 2009. SHGC values increase the glazing performance from .40 to .30.
Zone 4 - U-factor changes from .40 in 2006 to .35 in 2009. SHGC is not required in 2006 and 2009 codes.
Zones 4 (Marine) 5, 6, 7 and 8 – No U-factor changes. No changes to SHGC values, which are not required in either the 2006 or 2009 code.

Changes: 2012

Zone 1 – U-factor changes from 1.2 in 2006 and 2009 to no requirement in 2012. SHGC values increase the glazing performance from .30 in 2009 to .25 in 2012. As already discussed, compliance with a .30 SHGC may necessitate use of insulated, low-e coated windows. A .25 SHGC may require use of argon gas-filled windows.
Zone 2 - U-factor further changes from .65 in 2009 to .40 in 2012. SHGC values further strengthen from .30 in 2009 to .25 in 2012.
Zone 3 - U-factor further improves from .50 in 2009 to .35 in 2012. SHGC values further increase the glazing performance from .30 in 2009 to .25 in 2012.
Zone 4 - U-factor does not change from 2009 levels. The SHGC goes from no requirement in 2009 to .40 in 2012.
Zones 4 (Marine), 5 and 6 - U-factor changes from .35 in 2006 and 2009 codes to .32 in 2012. As in the 2006 and 2009 codes, there is no requirement for SGHC in 2012.
Zones 7 and 8 – U-factor changes from .35 in 2009 to .32 in 2012. There are no SHGC requirements.

HIGH-RISE MULTIFAMILY

Changes: 2009

The U-factors in Zones 1-8 do not change. The SHGC in Zones 7 and 8 changes from no requirement to .45.

Changes: 2012

The 2012 code breaks out the U-factor values based on the fenestration components. The SHGC values do not change from 2009 to 2012.

Zone 1 - U-factor changes from 1.20 in 2006 and 2009 codes for all fenestrations to the following:

- .50 for fixed windows.
- .65 for operable windows.
- 1.10 for doors.

Zone 2 - U-factor changes from .75 in 2006 and 2009 codes for all fenestrations to the following:

- .50 for fixed windows.
- .65 for operable windows.
- .83 for doors.

Zone 3 - U-factor changes from .65 in 2006 and 2009 codes for all fenestrations to the following:

- .46 for fixed windows.
- .60 for operable windows.
- .77 for doors.

Zone 4 - U-factor changes from .40 in 2006 and 2009 codes for all fenestrations to the following:

- .38 for fixed windows.
- .45 for operable windows.
- .77 for doors.

Zone 5 and Marine 4 - U-factor changes from .35 in 2006 and 2009 codes for all fenestrations to the following:

- .38 for fixed windows.
- .45 for operable windows.
- .77 for doors.

Zone 6 - U-factor changes from .35 in 2006 and 2009 codes for all fenestrations to the following:

- .36 for fixed windows.
- .43 for operable windows.
- .77 for doors.

Zones 7 and 8 - U-factor changes from .35 in 2006 and 2009 codes for all fenestrations to the following:

- .29 for fixed windows
- .37 for operable windows
- .77 for doors.

Estimated additional cost per unit:

- Low-e insulated windows and Doors have an up-charge of $10 to $15 per window unit. The cost range is $73 to $110 per unit. Glazing systems that require higher performance will have the insulation cavity between the glass panels filled with argon gas. The cost for argon gas windows is a $12 to $17 increase over the low-e windows. The cost range is $88 to $125.

Item	Chapter 4 Low-Rise Multifamily			Chapter 5 High-Rise Multifamily		
	IECC 2006	IECC 2009	IECC 2012	IECC 2006	IECC 2009	IECC 2012
	Zone 1			**Zone 1**		
Fenestration U-factor	1.2	1.2	NR	1.20	1.20	Fixed= .50 Operable = .65 Doors = 1.10
Glazing Fenestration SHGC	.40	.30	.25	PF<.25 =.25 .25<PF<.5 =.33 PF>.5 =.40	PF<.25 =.25 .25<PF<.5 =.33 PF>.5 =.40	.25
	Zone 2			**Zone 2**		
Fenestration U-factor	.75	.65	.40	.75	.75	Fixed = .50 Operable = .65 Doors = .83
Glazing Fenestration SHGC	.40	.30	.25	PF<.25 =.25 .25<PF<.5 =.33 PF>.5 =.40	PF<.25 =.25 .25<PF<.5 =.33 PF>.5 =.40	.25
	Zone 3			**Zone 3**		
Fenestration U-factor	.65	.50	.35	.65	.65	Fixed = .46 Operable = .60 Doors = .77
Glazing Fenestration SHGC	.40	.30	.25	PF<.25 =.25 .25<PF<.5 =.33 PF>.5 =.40	PF<.25 =.25 .25<PF<.5 =.33 PF>.5 =.40	.25
	Zone 4			**Zone 4**		
Fenestration U-factor	.40	.35	.35	.40	.40	Fixed = .38 Operable = .45 Doors = .77
Glazing Fenestration SHGC	NR	NR	.40	PF<.25 =.40 .25<PF<.5 =NR PF>.5 =NR	PF<.25 =.40 .25<PF<.5 =NR PF>.5 =NR	.40
	Zone 5 and Marine 4			**Zone 5 and Marine 4**		
Fenestration U-factor	.35	.35	.32	.35	.35	Fixed = .38 Operable = .45 Doors = .77
Glazing Fenestration	NR	NR	NR	PF<.25 =.40 .25<PF<.5 =NR	PF<.25 =.40 .25<PF<.5 =NR	.40

SHGC				PF>.5 =NR	PF>.5 =NR	
	Zone 6			**Zone 6**		
Fenestration U-factor	.35	.35	.32	.35	.35	Fixed = .36 Operable = .43 Doors = .77
Glazing Fenestration SHGC	NR	NR	NR	PF<.25 =.40 .25<PF<.5 =NR PF>.5 =NR	PF<.25 =.40 .25<PF<.5 =NR PF>.5 =NR	.40
	Zone 7 and 8			**Zone 7 and 8**		
Fenestration U-factor	.35	.35	.32	.35	.35	Fixed = .29 Operable = .37 Doors = .77
Glazing Fenestration SHGC	NR	NR	NR	PF<.25 =NR .25<PF<.5 =NR PF>.5 =NR	PF<.25 =.45 .25<PF<.5 =NR PF>.5 =NR	.45

1. The SHGC for glazing is based on a projection factor (PF). The 2012 code SHGC is based on projects.
2. The U-factor for the 2012 code is broken out into fenestration components fixed windows, operable windows and doors.

B.4 – Mechanical Systems

LOW-RISE MULTIFAMILY

The 2009 IECC imposes new requirements for programmable thermostats, duct tightness, pools and snow melt systems, and increases the R-value for pipe insulation. The 2012 code makes some revisions to the above, but it also includes additional requirements for mechanical ventilation and equipment sizing.

Programmable Thermostats

In the 2009 code, HVAC control provisions require programmable thermostats for forced-air furnace systems. The thermostat must be able to control heating and cooling on a daily schedule, include a setpoint to operate the system within a specified temperature range and have the ability to program setpoints with upper and lower temperature limits. A basic programmable thermostat is $10 to $15 more than a non-programmable thermostat.

Ductwork

The 2006 code required ducts to be sealed per Section M1601.3.1 of the International Residential Code, but the 2009 code will require tests when ductwork is run in unconditioned space.

This presents a challenge for a typical multifamily building, where duct work is often run in the unconditioned truss space above the top floor or in the attic of the building. Continuation of this practice will require that those ducts be sealed and tested, which has both time and cost impacts.

The 2009 code allows the ducts to be evaluated through one of two methods: the post-construction test or the rough-in test. Both involve sealing the register boots and pressurizing the system, but they have different

passing guidelines. For post-construction tests, the total air leakage cannot exceed 12 cfm per 100 square feet of conditioned space or leakage to outdoors. The rough-in test has a total leakage limit of 6 cfm per 100 square feet of conditioned space.

In the alternative, designers and builders may choose to run ductwork in the conditioned space. In corridors, the center portion of the truss can be raised to accommodate mechanical systems. In the living units, the ductwork can be run in soffits below the ceiling. However, this would add cost by requiring the installation of soffits in the unit and negatively affect the unit's ceiling height.

The cost for the duct test is $50 to $60 per unit. The cost to run the duct in conditioned space in the units and corridor is between $91 to $97 in a three story building and $68 to $73 per unit in a four story building.

Piping Insulation

In the 2009 and 2012 IECC, the insulation for mechanical piping will need to be thicker, increasing from a value of R-2 to R-3. The 2012 code also will require that any piping insulation exposed to weather be protected from damage and shielded from solar radiation.

In addition, the 2012 code boosts the insulation value for hot water systems from R-2 to R-3, and adds a provision for insulation based on diameter and run length. While the cost of the insulation is negligible, the cost to provide aluminum shielding to protect the piping insulation from solar radiation is $210 to $250 per unit.

Snow Melt Systems

The 2012 code includes additional requirements for snow melt systems that operate off a building's energy system. Such systems will now need to have automatic controls that can operate the system within specified temperature ranges. Most manufacturers already offer this feature, so this requirement should not result in significant cost impacts.

Fireplaces

The 2009 code requires that fireplaces be equipped with gasketed doors and outdoor combustion. This is intended to both prevent energy loss and improve indoor air quality. However, this requirement presents certain aesthetic and design impacts. The 2012 code further calls for tight-fitting flue dampers. Gasketed doors will add an estimated $250 to $275 per unit.

Pools and Spas

In 2009 code requires that pools with a heating system include a shut-off switch and timing switches that are set to a daily schedule. Heated pools will also require covers, unless 60 percent of the heat is derived from on-site energy. The 2012 code extends these requirements to permanently installed spas.

Mechanical Ventilation

The 2012 code adds new efficiency requirements for mechanical ventilation, following International Residential Code Section M1507. Previous codes already require the exhaust from bathrooms to be vented to the outside, but the 2012 code increases the minimum fan efficiency rate. This increase in fan efficiency has minimal cost impacts.

HVAC

The 2012 code includes a provision for sizing HVAC equipment. In the 2006 and 2009 codes, equipment is sized based on a load calculation and then selected from a manufacturer's table based on that load. Instead, the

2012 code requires the equipment to be sized in accordance with Air Conditioning Contractors of America (ACCA) manuals, based on a load calculation in accordance with ACCA manual J.

HIGH-RISE MULTIFAMILY

Ductwork

The duct and plenum insulation and sealing requirement remains the same from the 2006 code to the 2009 code, with one exception: all air ducts and filter boxes must be sealed to comply with Section 603.9 of the International Mechanical Code. Section 603.9 in turn requires that all ductwork be sealed per Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) standards. This requirement increases the degree of difficulty for sealing ducts, and workers will need training on how to properly meet the new standards. In terms of cost, the SMACNA requirements will add an estimated $40 to $50 per unit.

In addition, the 2012 code changes the insulation requirements for supply and return ducts in unconditioned spaces from R-5 to R-6.

Pipe Insulation

The 2009 code increases pipe insulation requirements - insulation of chilled- and hot-water piping with a diameter of greater than 1.5 inches increases from 1 inch to 1.5 inches. While the 2012 code completely changes the insulation requirements for pipe insulation, the thickness will still be based on pipe diameter and fluid temperatures. Multifamily buildings, however, should not be impacted by these changes in the 2012 code. The expense for the 2009 insulation changes is minimal, costing $5 to $10 per unit.

Water Heating

The 2009 and 2012 codes only minimally change service water heating requirements compared to previous code versions. Of note, the 2012 code extends the pool heating requirements to permanently installed spas.

HVAC

The 2009 and 2012 codes change the rules for calculating a building's heating and cooling loads. While the 2006 code requires that heating and cooling loads be calculated based on the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Fundamentals Handbook, the 2009 code requires multifamily projects to provide new calculations described in ASHRAE/ACCA Standard 183. In addition, the 2012 code requires that the calculated design loads include building envelope, lighting, ventilation and occupancy loads.

Required HVAC equipment efficiencies also increase under the 2009 code to a Seasonal Energy Efficiency Ratio (SEER) of 13.8 for an air-cooled split system. Multifamily projects also use Single Package Vertical Air Conditioners, which are covered under ASHRAE 90.1 – 2007, which is referenced in the IECC. These systems typically have an Energy Efficiency Ratio (EER) of 9. While air-cooled split systems are often more energy efficient appliances, they have a higher initial cost.

Snow Melt Systems

Under the 2009 code, snow melt systems operating off the building's energy system need automatic controls that can sense changes in temperature and precipitation.

Building Ventilation

The 2009 code introduces requirements for building ventilation. The code requires the ventilation to be either natural or mechanical and should comply with the International Mechanical Code, Chapter 4. This code sets minimum ventilation and exhaust rates for multifamily buildings, common spaces and individual dwelling units.

B.5 – Electrical Systems

LOW-RISE MULTIFAMILY

The 2009 IECC addresses lighting in residential dwelling units for the first time. New provisions require that a minimum of 50 percent of the lamps (i.e., bulbs) in permanently installed fixtures be high-efficacy, a requirement that will rise to 75 percent in 2012.

According to the IECC, the following are high-efficacy lamps:

1. Lamps of more than 40 watts that are 60 lumens/w.
2. Lamps that are between 15 to 40 watts that are 50 lumens/w.
3. Lamps of fewer than 15 watts that are 40 lumens/w.

Traditional incandescent bulbs do not comply with these new high-efficiency benchmarks. The most common alternatives available are compact fluorescent bulbs (CFLs) and light-emitting diodes (LED lighting); although, some manufacturers are producing high-efficiency incandescent bulbs that can satisfy these requirements. All of these bulb options will cost significantly more than traditional bulbs, however. Also, CFLs and LEDs are not appropriate for all lighting applications. LED lighting is the most expensive choice, but these bulbs often offer the greatest energy savings and longest lifespan.

According to data from the U.S. Department of Energy, the average 100-watt incandescent bulb costs $0.60, while a comparable CFL costs $3.40. LED bulbs can cost as much as $50 each, but costs are expected to decrease as more products become commercially available.

HIGH-RISE MULTIFAMILY

The 2009 IECC eliminates the existing exemption for dwelling unit lighting for multifamily buildings. Apartment units will now be required to have high-efficacy lamps in 50 percent of the permanently installed lighting fixtures; otherwise, they must comply with the full requirements of the commercial lighting chapter. This includes extensive provisions for lighting controls, automatic shutoff devices and other features not conducive to residential occupancy. Like low-rise multifamily buildings, the 2012 IECC increases high-efficiency lamp percentage from 50 percent to 75 percent.

The IECC also covers a multifamily building's common areas, including amenities, maintenance spaces and offices. The 2009 IECC requires the installation of daylighting controls (See Section B.7), while the 2012 IECC requires occupancy sensors for office spaces, janitor/storage spaces and other spaces 300 square feet or fewer. The cost for a wall switch with an occupancy sensor is approximately $4 to $5 more than a standard light.

While no changes for interior lighting power allowances are made in the 2009 code (See Table 505.5.2), a reduction occurs in the 2012 code (See Table 506.3). This will likely necessitate the use of a lighting design professional to ensure security and aesthetics in public spaces.

B.6 – Simulated Performance Alternative

Building codes and standards often contain both prescriptive and performance compliance paths. Prescriptive provisions specify exactly what a user must do to comply with the provision's requirements and typically set minimum or maximum values for building components. Performance provisions generally specify a desired result or level of efficiency, but enable the user to determine how to achieve it. Code compliance is achieved with this option when a building's total annual energy cost is equal to or less than the annual energy cost of the

standard reference design. The code dictates the specifications for the standard reference design and requires the use of computer modeling to demonstrate compliance.

The IECC provides a performance compliance path for both categories of multifamily buildings (those with three stories or less and those of four stories or more).

B.7 – Daylight Zones and Lighting Controls

Changes: 2009

The 2009 code changes how lighting systems are applied to daylighting zones. A daylighting zone is defined as an area adjacent to a window or under a skylight. (See Appendix A.3, Image A.3.9). This new requirement only applies to high-rise multifamily buildings, and is not likely to affect individual apartment units.

However, these requirements do extend to common areas such as community rooms, lounges and fitness centers. In daylighting zones, individual lighting controls must be provided to control the zone's lighting independently from the general room lighting. This requires an additional lighting circuit for these spaces. The goal is to take advantage of daylight to meet the general lighting needs for a space.

Changes: 2012

The 2012 IECC provides a choice for lighting controls - manual or automatic. Automatic lighting controls can reduce the lighting power based on the daylighting conditions. These controls are readily available on the market, but are expensive.

B.8 – Additional Energy Performance

The 2012 code for high-rise multifamily buildings requires buildings to either exceed the HVAC efficiency requirements or lighting system requirements. One compliance option is to provide on-site renewable energy equal to 3 percent of the building's mechanical, service water heating and lighting energy cost.

While on-site renewable energy systems, such as photovoltaic panels or wind turbines, have been available for some time, these systems are not prevalent in typical, market-rate multifamily projects. Using on-site energy systems at a property would pose substantial new costs, design considerations, training needs and ongoing operations and maintenance needs. Incorporating such systems would require careful evaluation of a project's size, location, site orientation and other factors.

The 2012 code requires commonly used, 13 SEER HVAC split systems to increase its efficiency to meet 15 SEER. 15 SEER units may involve variable-speed-drive units and cost significantly more than standard SEER 13 units.

Where lighting system efficiency is improved, lighting levels must be reduced from .7 watts/square feet to .66 watts/square feet. This would be the most cost-effective efficiency option in this section and could possibly reduce the number of lighting fixtures. When properly designed and installed, the proposed reduction in watts/square foot should be imperceptible to the eye, but the change will require a reconfiguration of the lighting fixtures.

B.9 – Building Commissioning

The 2012 code requires that common area spaces, office space and back of house spaces of high-rise multifamily buildings be "commissioned." While commissioning is becoming more common for commercial buildings, it will be new to the multifamily sector. The intent is to verify and ensure that the mechanical systems are designed, installed and calibrated to operate as intended. Individual dwelling units are exempt from this process.

Under this code change, design professionals or approved agents must act as the commissioning authority and develop a plan for the building. The plan must include:

1. A narrative describing the commissioning activities and the personnel who will be involved in each activity;
2. A list of equipment to be commissioned (Systems that should be commissioned include HVAC, controls, economizers (if required) and lighting controls);
3. Functions to be tested;
4. Conditions under which testing will be performed;
5. Activities to be performed for systems to be re-tested; and
6. Measurable criteria for performance.

The commissioning authority will issue a preliminary report to the building owner detailing any deficiencies and any deferred testing. Once the test procedures are final, the commissioning agent will issue a final report with the procedures used and the criteria for acceptance. Building owners should also receive operation and maintenance manuals. This will add a new set of fees from designers and contractors.

B.10 – Cost Summary

Costs in this report are calculated based on a model multifamily building design, which is suitable in all climate zones. This model was used for both the low-rise, three-story and high-rise, four-story calculations:

- Units per floor: 9 - with 2 one-bedroom units, 3 two-bedroom units and 4 three-bedroom units;
- Corridors are enclosed with no exterior exposure;
- Staircases: 2;
- Elevators: 0;
- Gross floor area per floor: 10, 174 square feet;
- Construction: Slab on grade, with 2x4 wood framing;
- Exterior: The three-story model is all brick. The four-story model is brick for the first three floors, with fiber cement lap siding at the balconies and at the fourth story and above;
- Fenestrations: 3'x5' windows and 3'x7' doors. Glass balcony doors. Majority of rooms, with the exception of closets, have one window. Corner rooms have two windows;
- Insulation: Exterior wall insulation is batt insulation in the framing cavity. Attic insulation is blown-in fiberglass insulation;
- HVAC: Split system, with ground-mounted condensing units and a SEER 13 efficiency; and
- Lighting: Incandescent at vanities; fluorescent for general room lighting in kitchens, bathrooms and bedrooms.

Costs were extrapolated from the Engineering News-Record's Square Foot Costbook 2010 edition, as well as, practical project cost considerations. The cost estimates illustrate subcontractor costs for material, labor and taxes, and general contractor overhead and fees. The overhead is based on 10 to 11 percent of the subcontractor's costs.

A construction consultant reviewed the data and calculations in this paper and found that the costs, which were divided by total units to get a per-unit figure, were comparable to the costs in a medium market. That cost data was then applied to the construction changes required by the new codes. As such, the costs reflect only the incremental changes in expense for complying with the new codes over the last code version. For example, the cost summary for 2009 Zone 2, High-Rise shows an attic insulation cost of $70.65 - $98.91. This estimate represents only the material and labor costs involved in adding the 2.5 inches of insulation needed to go from IECC 2006's R-30 requirement to IECC 2009's R-38 requirement. It does not reflect the total cost of installing R-38 in a project. Similarly, 2012 Zone 2, High-Rise cost summaries do not include an estimate for attic insulation, since the R-38 requirement does not change from 2009 to 2012.

One note: The estimated costs listed in this report are conceptual and provide general ideas about how these code changes will affect the per unit construction costs (and sometimes practices) in typical multifamily housing. These costs do not reflect all of the construction detailing associated with each change and should not be used for budget pricing. In addition, some cost items represent aggregated expenses associated with the identified compliance requirement (such as façade accessories and furring strips).

With that caveat, the following summarizes the per unit costs that are likely to be incurred when the new code editions are adopted. Where the code provides options for compliance, the most cost-effective alternatives are typically listed below, along with their estimated costs. Exceptions to this methodology are found in some 2012 cost summaries where new compliance options were introduced using substantially different wall configurations than previous code versions. There, both compliance options are shown to illustrate the differences between building design alternatives.

Of note, the new optional, compliance packages are sometimes more expensive than the existing compliance alternatives. For example, a lap-sided, high-rise building project in Zone 8 would spend $4,927.87 to comply with the 2012 IECC using the R-20 plus R-10 insulation option (a new compliance option in the 2012 code). However, that same building would spend just $341 to comply using the R-13 plus R-15.6 option.

IECC 2009 Edition

***LOW-RISE MULTIFAMILY**
Zones 1, 2 and 3

• Building Envelope Inspection - Visual	$150 - $170
• Fenestrations	$72.96 – 109.44
• Thermostats	$10 - $15
• Duct Testing at Top Floor	$50 - $60
• General Contractor Overhead and Fees	$28.30 - $38.99
	$311.26 - $393.43

Zones 4, 5, 6, 7 and 8

• Building Envelope Inspection - Visual	$150 - $170
• Thermostats	$10 - $15
• Duct Testing at Top Floor	$50 - $60
• General Contractor Overhead and Fees	$21 - $26.95
	$231 - $271.95

***HIGH-RISE MULTIFAMILY**
Zones 1, 2 and 3

• R-38 Attic Insulation	$70.65 - $98.91
• Thermostats	$10 - $15
• Chilled and Hot Water Piping Insulation	$5 - $10
• General Contractor Overhead and Fees	$8.57 - $13.63
	$94.22 - $137.54

Zones 4 and 5

• R-38 Attic Insulation	$70.65 - $98.91
• R-3.8 Continuous Insulation	$737.44 - $871.52
• R-10 Slab Insulation	$29.43 - $31.06
• Thermostats	$10 - $15
• Chilled and Hot Water Piping Insulation	$5 - $10
• General Contractor Overhead and Fees	$85.25 - $112.91
	$937.98 - $1,139.40

Zone 6

	Lap Siding Veneer	Brick Veneer
• R-38 Attic Insulation	$70.65 - $98.91	$70.65 - $98.91
• R-7.5 Continuous Insulation	$2,346.40 - $2,748.64	$1,855.98 - $2,206.98
• R-15 Slab Insulation	$58.85 - $61.90	$58.85 - $61.90
• Thermostats	$10 - $15	$10 - $15
• Chilled and Hot Water Piping Insulation	$5 - $10	$5 - $10
• General Contractor Overhead and Fees	$249.09 - $322.79	$200.05 - $263.21
	$2,739.99 - $3,257.24	**$2,200.53 - $2,656.00**

Zone 7

	Lap Siding Veneer	Brick Veneer
• R-7.5 Continuous Insulation	$2,346.40 - $2,748.64	$1,855.98 - $2,206.98
• R-15 Slab Insulation	$58.85 - $61.90	$58.85 - $61.90
• Fenestrations	$72.78 - $109.17	$72.78 -$109.17
• Thermostats	$10 - $15	$10 - $15
• Chilled and Hot Water Piping Insulation	$5 - $10	$5 - $10
• General Contractor Overhead and Fees	$249.30 - $323.92	$200.26 - $264.33
	$2,742.33 - $3,268.63	**$2,202.87 - $2,667.38**

Zone 8

	Lap Siding Veneer	Brick Veneer
• R-49 Attic Insulation	$98.91 - $127.18	$98.91 - $127.18
• R-15.6 Continuous Insulation	$2,560.93 - $2,748.64	$2,028.54 - $2,176.76
• R-20 Slab Insulation	$58.85 - $61.47	$58.85 - $61.47
• Fenestrations	$72.78 - $109.17	$72.78 - $109.17
• Thermostats	$10 - $15	$10 - $15
• Chilled and Hot Water Piping Insulation	$5 - $10	$5 - $10
• General Contractor Overhead and Fees	$280.65 - $337.86	$227.41 - $274.95
	$3,087.12 - $3,409.32	**$2,501.49 - $2,774.53**

IECC 2012 Edition

***LOW-RISE MULTIFAMILY**

Zone 1

• Building Envelope Testing – Blower Door	$150 - $180
• Fenestrations (High Performance)	$87.56 - $124.04
• Shielding for Refrigerant Piping	$200 - $220
• General Contractor Overhead and Fees	$43.76 - $57.64
	$481.32 - $581.68

Zone 2

• Building Envelope Testing – Blower Door	$150 - $180
• R-38 Attic Insulation	$94.20 - $131.89
• Fenestrations	$87.56 - $124.04
• Shielding for Refrigerant Piping	$200 - $220
• General Contractor Overhead and Fees	$53.18 - $72.15
	$584.94 - $728.08

Zone 3 with R-13 and R-5 Insulation Option

	Lap Siding Veneer	Brick Veneer
• Building Envelope Testing – Blower Door	$150 - $180	$150 - $180
• R-38 Attic Insulation	$94.20 - $131.83	$94.20 - $131.89
• R-5 Continuous Insulation	$1,983.90 - $2,314.55	$1,371.10 - $1,637.42
• Fenestrations (High Performance)	$87.56 - $124.04	$87.56 - $124.04
• Shielding for Refrigerant Piping	$200 - $220	$200 - $220
• General Contractor Overhead and Fees	$251.57 - $326.75	$190.29 - $252.27
	$2,767.23 - $3,297.17	**$2,093.15 - $2,545.62**

Zone 3 with R-20 Insulation Option

• Building Envelope Testing – Blower Door	$150 - $180
• R-38 Attic Insulation	$94.20 - $131.89
• R-20 Cavity Insulation	$1,124.21 - $1,289.53
• Fenestrations(High Performance)	$87.56 - $124.04
• Shielding for Refrigerant Piping	$200 - $220
• General Contractor Overhead and Fees	$165.60 - $214.00
	$1,821.57 - $2,159.46

Zone 4 (Not Marine) with R-13 and R-5 Insulation Option

	Lap Siding Veneer	Brick Veneer
• Building Envelope Testing – Blower Door	$150 - $180	$150 - $180
• R-49 Attic Insulation	$131.89 - $169.57	$131.89 - $169.57
• R-5 Continuous Insulation	$1,983.90 - $2,314.55	$1,371.10 - $1,637.42
• Shielding for Refrigerant Piping	$200 - $220	$200 - $220
• General Contractor Overhead and Fees	$246.58 - $317.25	$185.30 - $242.77
	$2,712.37 - $3,201.37	**$2,038.29 - $2,449.76**

Zone 4 (Not Marine) with R-20 Insulation Option

• Building Envelope Testing – Blower Door	$150 - $180
• R-49 Attic Insulation	$131.89 - $169.57
• R-20 Cavity Insulation	$1,124.21 - $1,289.53
• Shielding for Refrigerant Piping	$200 - $220
• General Contractor Overhead and Fees	$160.61 - $204.50
	$1,766.71 - $2,063.60

Zones 5 and 4 (Marine)

• Building Envelope Testing – Blower Door	$150 - $180
• R-49 Attic Insulation	$131.89 - $169.57
• Shielding for Refrigerant Piping	$200 - $220
• General Contractor Overhead and Fees	$48.19 - $62.65
	$530.08 - $632.22

Zone 6 with R-13 and R-10 Insulation Option

	Lap Siding Veneer	Brick Veneer
• Building Envelope Testing – Blower Door	$150 - $180	$150 - $180
• R-10 Continuous Insulation	$1,983.90 - $2,248.42	$1,440.29 - $1,645.56
• Shielding for Refrigerant Piping	$200 - $220	$200 - $220
• General Contractor Overhead and Fees	$233.39 - $291.33	$179.03 - $225.01
	$2,567.29 - $2,939.74	**$1,969.32 - $2,270.57**

Zone 6 with R-20 and R-5 Insulation Option

	Lap Siding Veneer	Brick Veneer
• Building Envelope Testing – Blower Door	$150 - $180	$150 - $180
• R-5 Continuous Insulation	$1,983.90 - $2,314.55	$1,371.10 - $1,637.42
• Shielding for Refrigerant Piping	$200 - $220	$200 - $220
• General Contractor Overhead and Fees	$233.39 - $317.30	$172.11 - $224.12
	$2,567.29 - $3,013.15	**$1,893.21 - $2,261.53**

Zones 7 and 8 with R-20 and R-5 Insulation Option

	Lap Siding Veneer	Brick Veneer
• Building Envelope Testing – Blower Door	$150 - $180	$150 - $180
• R-5 Continuous Insulation	$1,983.90 - $2,314.53	$1,371.10 - $1,637.42
• Shielding for Refrigerant Piping	$200 - $220	$200 - $220
• General Contractor Overhead and Fees	$233.39 - $298.60	$172.11 - $224.12
	$2,567.29 - $3,013.13	**$1,893.21 - $2,261.54**

Zones 7 and 8 with R-13 and R-10 Insulation Option

	Lap Siding Veneer	Brick Veneer
• Building Envelope Testing – Blower Door	$150 - $180	$150 - $180
• R-10 Continuous Insulation	$1,719.38 - $2,016.96	$1,175.77 - $1,414.10
• Shielding for Refrigerant Piping	$200 - $220	$200 - $220
• General Contractor Overhead and Fees	$206.94 - $263.67	$152.58 - $199.55
	$2,276.32 - $2,680.63	**$1,678.35 - $1,814.10**

***HIGH-RISE MULTIFAMILY**

Zones 1, 2 and 3 with R-20 Insulation Option

• R-20 Cavity Insulation	$1,139.68 - $1,307.28
• Fenestrations	$72.78 - $109.17
• Additional Duct Insulation	$10 - $12.50
• General Contractor Overhead and Fees	$122.25 - $157.18
	$1,344.71 - $1,586.13

Zones 1, 2 and 3 with R-13 and R-3.8 Insulation Option

• R-3.8 Continuous Insulation	$737.44 - $871.52
• Fenestrations	$72.78 - $109.17
• Additional Duct Insulation	$10 - $12.50
• General Contractor Overhead and Fees	$82.02 - $109.25
	$902.24 - $1,102.44

Zone 4 (Not Marine) with R-20 Insulation Option

• Building Envelope Testing – Blower Door	$300 - $350
• R-20 Cavity Insulation	$1,139.68 - $1,307.28
• Additional Duct Insulation	$10 - $12.50
• General Contractor Overhead and Fees	$144.97 - $183.68
	$1,594.65 - $1,853.46

Zone 4 with R-13 and R-3.8 Insulation Option

• Building Envelope Testing – Blower Door	$300 - $350
• Additional Duct Insulation	$10 - $12.50
• General Contractor Overhead and Fees	$31 - $36.25
	$341 - $398.75

Zones 5 and 4 (Marine) with R-20 and R-3.8 Insulation Option

• Building Envelope Testing – Blower Door	$300 - $350
• R-49 Attic Insulation	$98.91 - $127.18
• R-3.8 Continuous Insulation	$1,877.12 - $2,178.80
• Additional Duct Insulation	$10 - $12.50
• General Contractor Overhead and Fees	228.60 - $293.53
	$2,514.63 - $2,962.01

Zones 5 and 4 (Marine) with R-13 and R-7.5 Insulation Option

	Lap Siding Veneer	Brick Veneer
• Building Envelope Testing –Blower Door	$300 - $350	$300 - $350
• R-49 Attic Insulation	$98.91 - $127.18	$98.91 - $127.18
• R-7.5 Continuous Insulation	$1,608.96 - $1,877.12	$1,118.55, $1,335.46
• Additional Duct Insulation	$10 - $12.50	$10 - $12.50
• General Contractor Overhead and Fees	$201.79 - $260.35	$152.72 - $200.76
	$2,219.66 - $2,627.15	**$1,680.18 - $2,025.82**

Zones 6 and 7 with R-20 and R-3.8 Insulation Option

• Building Envelope Testing – Blower Door	$300 - $350
• R-49 Attic Insulation	$98.91 - $127.18
• R-3.8 Continuous Insulation	$1,877.12 - $2,178.80
• Additional Duct Insulation	$10 - $12.50
• General Contractor Overhead and Fees	$228.60 - $293.53
	$2,514.63 - $2,962.01

Zones 6 and 7 with R-13 and R-7.5 Insulation Option

	Lap Siding Veneer	Brick Veneer
• Building Envelope Testing – Blower Door	$300 - $350	$300 - $350
• R-49 Attic Insulation	$98.91 - $127.18	$98.91 - $127.18
• Additional Duct Insulation	$10 - $12.50	$10 - $12.50
• General Contractor Overhead and Fees	$40.89 - $47.97	$40.89 - $47.97
	$449.80 - $537.65	**$449.80 - $537.65**

Zone 8 with R-20 and R-10 Insulation Option

	Lap Siding Veneer	Brick Veneer
• Building Envelope Testing – Blower Door	$300 - $350	$300 - $350
• R-10 Continuous Insulation	$4,169.89 - $4,793.36	$3,600.65 - $4,184.69
• Additional Duct Insulation	$10 - $12.50	$10 - $12.50

• General Contractor Overhead and Fees	$447.99 - $567.14	$391.07 - $500.19
	$4,927.87 - $5,723.00	**$4,301.72 - $5,047.38**

Zone 8 with R-13 and R-15.6 Insulation Option

	Lap Siding Veneer	Brick Veneer
• Building Envelope Testing – Blower Door	$300 - $350	$300 - $350
• Additional Duct Insulation	$10 - $12.50	$10 - $12.50
• General Contractor Overhead and Fees	$31 - $36.25	$31 - $36.25
	$341 - $398.75	**$341 - $398.75**

Additional Costs and Fees

- Commissioning will result in additional professional design fees to the project's cost. A commission agent will need to be retained to develop the plan, review shop drawings, conduct field inspections, and review test reports on the systems to be commissioned. The commissioning agent can be a third-party hired by the owner or be a member of the mechanical, engineering and plumbing design team. The commissioning fees are project-specific based on the types of systems being commissioned. Based on the cost model, the fee will range from $100 to $120 per unit.

- It is not expected that the basic services fees will increase due to the code changes. There may be additional fees for envelope inspections.

- Permit and inspection fees may increase, depending on local jurisdictions and how they handle any additional inspections.

B.11 Recommendations

After researching the requirements, alternatives, and costs associated with the IECC 2009 and 2012 changes, we want to offer the following advice to multifamily builders and developers who want to incorporate the IECC changes without pricing their properties out of the market:

1. Using best practices to seal the exterior envelope is cost-effective and will help achieve energy savings. The envelope should be tested with a blower door test to verify that the envelope is well-sealed.
2. Adding R-3.8 (.75" thick) insulation board applied to the exterior of the building will prevent thermal bridging, which is a key factor in energy loss. We believe that adding continuous insulation of higher values will not significantly add to the energy savings realized by the building, and any savings that can be achieved are not cost effective due to the increased construction cost and changes in design necessary to accommodate the additional insulation.
3. Increasing the overall R-value of the thermal insulation over the 2006 code will again provide some increase in cost savings. However, where framing sizes must increase or the exterior insulation exceeds a thickness of one inch, any savings is not cost effective. This also decreases the rental space of the building, and forces the reconfiguration of rental units in order to meet design challenges necessary to comply with accessibility requirements.

4. The increased performance criteria for doors and windows do conserve energy and save money. These energy-efficient fenestration systems are on the market, and their additional expense will be offset by the energy savings realized.
5. The increased performance criteria for HVAC and lighting systems do save money in a multifamily building. Like the fenestration systems, these HVAC and lighting systems are available on the market. Many are being installed without cost impacts.

Appendix A.1 – IECC Code Comparison from the 2006 Edition to the 2009 Edition

International Energy Conservation Code Comparision
2006 Edition to 2009 Edition

Section	Paragraph Title	Heading	Revision Type	Comment
Section 101	101.4	Applicability	New	Application of Code Added Exceptions 5. Regarding Roofing 6. Regarding Replacement of door. 7. Regarding alterations of luminaries 8. Regarding alterations of lamps and ballasts
	101.4.5	Change in Space Conditioning	New	Space altered to be conditioned shall comply to code
	101.4.6	Mixed Occupancy	Revised	Paragraph number change formerly 101.4.5
	102.1	Identification	Replaced	The paragraph is replaced by paragraph 102.1 General. The paragraph regards the use of material, method of construction, design or insulating systems.
Section 102	102	Materials, Methods and Equipment	Relocated	This section is now Section 303
	102.1	Building Thermal Envelope Insulation	Relocated/Replaced	This section is now section 303.1.1
	102.1.1.1	Blown or Sprayed Roof/Ceiling Insulation	Relocated	This section is now Section 303.1.1.1
	102.1.2	Insulation Work Installation	Relocated	This section is now Section 303.1.2
	102.1.3	Fenestration Product Rating	Relocated	This section is now Section 303.1.3
	102.2	Installation	Relocated	This section is now Section 303.2
	102.2.1	Protection of Exposed Foundation Insulation	Relocated	This section is now Section 303.2.1
	102.3	Maintenance Information	Relocated	This section is now Section 303.3
Section 103	103	Alternate Materials Method of Construction, Design or Insulation Systems	Relocated	This section is now Section 102
Section 104	104	Construction Documents	Relocated	This section is now Section 103

Appendix A.1 – IECC Code Comparison from the 2006 Edition to the 2009 Edition

Section	Paragraph Title	Heading	Revision Type	Comment
	104.1	General	Revised (103.1)	The revision construction documents to be prepared by a registered professional as required by the jurisdiction
	104.2	Information on Construction Documents	Revised (103.2)	The revision provides additional instruction on document information
	103.3	Examination of Documents	New	The paragraph requires examination of documents by code official
	103.3.1	Approval of Construction Documents	New	Requires approval of documents by code official
	103.3.2	Previews Approval	New	Does not require changes in contract documents for projects previously permitted
	103.3.3	Phased Approval	New	Allows permit of energy conservation system prior to the building permit
	103.4	Amended Construction Documents	New	Drawing changes made after approval are to be resubmitted
	103.5	Retention of Construction Documents	New	The code official shall keep a set of approved drawings
Section 105	105	Inspections	Relocated	This Section is now Section 104
	105.1	General	Relocated	This section is now Section 104.1
	105.2	Required Approvals	Relocated/Revised	This section is now Section 104.2. The revision provides additional instruction on inspection sequence
	105.3	Final Inspection	Relocated	This section is now Section 104.3
	105.4	Re-Inspection	Relocated	This section is now Section 104.4
	104.5	Approved Inspection Agencies	New	The paragraph allows the code official to accept reports from approved inspection engineers
	104.6	Inspection Request	New	The paragraph requires the permit holder or agent will notify code official for inspection
	104.7	Reinspection and Testing	New	The paragraph work that does not pass to be reinspected
	104.8	Approval	New	The paragraph requires the code official shall issue a narrative of approval
	104.8.1	Revocation	New	The paragraph allows the code official to revoke a native of approval based on incorrect information

Appendix A.1 – IECC Code Comparison from the 2006 Edition to the 2009 Edition

Section	Paragraph Title	Heading	Revision Type	Comment
Section 106	106	Validity	Relocated	This section is now Section 105
	106.1	General	Relocated	This section is now Section 105.1
Section 107	107	Reference Standards	Relocated	This Section is new 106
	107.1	General	Relocated	This section is now Section 106.1
	107.2	Conflicting Requirements		This Section is now Section 106.2
	106.3	Application of References	New	This paragraph requires reference standards not called by number shall be part of this code
	106.4	Other Laws	New	This paragraph states that this code will not nullify any current law
	107.1	Fees	New	This paragraph states that a permit will not be issued until fees are paid
	107.2	Schedule of Permit Fees	New	This paragraph notes fees are based on schedules from building official
	107.3	Work Commencing Before Permit Issue	New	This paragraph notes that additional fees will be required for work started before permit issue
	107.4	Related Fees	New	This paragraph notes that fees paid for permit do not relieve applicant from other fees pre-scheduled by law
	107.5	Refunds	New	This paragraph notes that the code official shall establish refund policy
Section 108	108.1	Authority	New	This paragraph notes that the code official has authority to stop work
	108.2	Issuance	New	This paragraph allows the code official to issue a stop work order stating reason and conditions for resumption
	108.3	Emergencies	New	This paragraph allows the code official, under emergency conditions, to stop work without written notice
	108.4	Failure to Comply	New	This paragraph states that anyone continuing to work is liable for a fine
Section 109	109.1	General	New	this paragraph establishes a board of approvals to review rulings made by the code official
	109.2	Limitations on Authority		This paragraph does not allow the board of approvals to
	109.3	Qualifications		This paragraph defines the members of the board of

Section	Paragraph Title	Heading	Revision Type	Comment
				approvals to be a qualified persons and not employees of
Chapter 2 - Definitions				
Section 201				
Section 202		L-Factor (Thermal Conductance)	New	Coefficient of heat transmission
		Daylight Zone - Under Skylights	New	Daylight zone under skylights
		Daylight Zone - Adjacent to Vertical Fenestration	New	Daylight zone at windows
		Demand Control Ventilation	New	Automated Ventilation System
		Fan Break Horsepower	New	Horsepower delivered to fan shaft
		Fan System BNP	New	Sum of fan break horsepower for all fans
		Fan System Design Conditions	New	Fan operation conditions
		Fan System Motor Nameplate HF		Sum of all fan nameplate horsepower
		F-Factor	New	Heat loss factor at slab on grade
		High-Efficiency Lamps	New	Fluorescent lamps with a minimum efficiency
		Nameplate Horsepower	New	Horsepower rate listed on motor nameplates
		Vapor Retarder	Deleted	

Appendix A.1 – IECC Code Comparison from the 2006 Edition to the 2009 Edition

Section	Paragraph Title	Heading	Revision Type	Comment
Chapter 3 - Definitions				
Section 301	301.2	Warm Humid Counties	Revised	The revision changes the referenced table from 301.1 to 301.1
	301.3.1	Warm Humid Criteria	Deleted	
	Table 301.1	Climate Zones by State , County and Territories	Revised	The table was revised to include designations for Moist, Dry and Marine locations
	Table 301.2	Warm Humid Counties and Territories	Deleted	
	Table 301.3(1)	International Climate Zone Definitions	Revised	Add criteria to warm-humid definition
Section 302				
Section 303	303.1	Identification	New	Requirement for materials, system and equipment indicating compliance to code
	303.1.1	Building Thermal Envelope Insulation	Relocated	This paragraph was formerly paragraph 102.1.1
	303.1.1.1	Blown or Sprayed Roof/Ceiling Insulation	Relocated	This paragraph was formerly paragraph 102.1.1.1
	303.1.2	Insulation Mark Insulation	Relocated	This paragraph was formerly paragraph 102.1.2
	Table 303.1.3(1)	Default Glazed Fenestration V-Factor	Relocated	This Table was formerly Table 102.1.3(1)
	Table 303.1.3(2)	Default Door V-Factor	Relocated	This Table was formerly Table 102.1.3(2)
	Table 303.1.3(3)	Default Glazed Fenestration SHGC	Relocated	This Table was formerly Table 102.1.3(3)
	303.1.4	Insulation Product Rating	New	This paragraph sets the standards for determining R-Values
	303.2	Installation	Relocated	This paragraph was formerly paragraph 102.2
	303.2.1	Protection of Exposed Foundation Insulation	Relocated	This paragraph was formerly paragraph 102.2.1
	303.3	Maintenance Information	Relocated	This paragraph was formerly paragraph 102.3

Section	Paragraph Title	Heading	Revision Type	Comment
Chapter 4 - Residential Energy Efficiency				
Section 401	401.2	Compliance	Revised	The paragraph changes sections of compliance
	401.3	Certificate	Revised	This paragraph adds additional requirements of the certificate to be posted on the electrical distribution panel
Section 402	402.1.3	U-Factor Alternative	Revised	The revision deletes the exception
	402.2.1	Ceilings with Attic Spaces	Revised	The revision does not allow this approach to apply to U-Factor Alternative or UA Alternative
	402.2.2	Ceiling Without Attic Spaces	Revised	The revision deletes the percentage limitation for the insulated area. It also does not allow this approach to supply U-Factor Alternative.
	402.2.3	Access Hatches and Door	New	The paragraph adds requirements for access hatches from conditioned spaces for unconditioned spaces
	402.2.4	Steel Frame Ceilings Walls and Floors	Revised/Relocated	This section was formerly 402.2.5. It also adds an exception for climate zones 1 and 2
	402.2.5	Floor	Relocated	This section was formerly 402.2.6
	402.2.6	Basement Walls	Relocated	This section was formerly 402.2.7
	402.2.7	Slab-On-Grade Floor	Relocated	This section was formerly 402.2.8
	402.2.8	Crawl Space Walls	Relocated	This section was formerly 402.2.9
	402.2.9	Masonry Veneer	Relocated	This section was formerly 402.2.10
	402.2.10	Thermally Isolated Sunroom Insulation	Relocated	(402.2.11)
	402.3.3	Glazed Fenestration Exemption	Revised	The revision does not apply to the exemption to apply the U-Factor alternative or the UA Alternative
	402.3.4	Opaque Door Exemption	Revised	The revision does not apply the exception to the U-Factor alternative or the UA Factor Alternative
	402.4.1	Building Thermal Envelope	Revised	The revision added, attic access opening and rim joist junctions to list of items

Appendix A.1 – IECC Code Comparison from the 2006 Edition to the 2009 Edition

Section	Paragraph Title	Heading	Revision Type	Comment
	402.4.2	Air Sealing and Insulation	New	The paragraph requires the air tightness and insulation installation be demonstrated to comply to the code. See Section - B.1 for narrative on air tightness and insulation testing.
	402.4.2.1	Testing Option	New	This paragraph offers a testing option for demonstration that the air leakage and insulation installation meets code. See Section - B.1 for narrative on testing options
	402.4.2.2	Visual Inspection Option	New	This paragraph offers an inspection option for demonstrating that the air leakage and insulation meets code. See Section - B.1 for narrative on testing
	402.4.3	Fireplaces	New	This paragraph requires all new wood burning fireplaces to have gasketed doors and outdoor composition air.
	402.4.2	Fenestration Air Leakage	Relocated	This section was formerly 402.4.4
	402.4.3	Recessed Lighting	Relocated/Revised	This section was formerly 402.4.5. The revision deletes the requirement for clearances at combustable material and insulation
	402.5	Moisture control	Deleted	
	402.6	Maximum Fenestration U-Factor and SHGC	Relocated	This section was formerly 402.5
	Table 402.1.1	Insulation and Fenestration Requirements by Component	Revised	The Table increases the values for the fenestration U-Value, glazed fenestration SHGC, mass wall R-Value, Floor R-Value and Basement wall R-Value. See Section C for table. See Section - B.2 for narrative on insulation.
	Table 402.1.3	Equivalent U-Factors	Revised	The Table change the U values for floor and basement walls. See Section C for table
	Table 402.2.4	Steel Frame Ceiling, Walls and Floor Insulation	Revised/Relocated	The table is now 402.2.5. The table changes the R value for Steel framed walls. See Section C for Table. See Section - B.2 for a narrative on isolation.
	Table 402.4.2	Air Barrier and Insulation Inspection Component Criteria	New	This Table provides the installation criteria for each component of the building air barrier. See Section C for table
Section 403	403.1.1	Programmable Thermostat	New	The paragraph requires a forced-air furnace to be equipped with a programmable thermostat. The thermostat shall operate within certain ranges.

Appendix A.1 – IECC Code Comparison from the 2006 Edition to the 2009 Edition

Section	Paragraph Title	Heading	Revision Type	Comment
	403.1.1	Heat Pump Supplementary Heat	Revised/Relocated	(403.1.2) The revision makes this a mandatory requirement
	403.2.2	Sealing	Revised	The revision makes this a mandatory requirement. The revision also requires verification on duct tightness. There are two testing options. Post construction and rough-in test. The exception does not require testing if all the air handlers and ducts are in a conditioned space.
	403.3	Mechanical System Piping Insulation	Revised	This revises the piping insulation R-Value to a minimum of R-3. It also makes it a mandatory requirement.
	403.4	Circulating Hot Water Systems	Revised	The revision makes this a mandatory requirement
	403.5	Mechanical Ventilation	Revised	The revision makes this a mandatory requirement
	403.5	Equipment Sizing	Revised	The revision makes this a mandatory requirement
	403.7	Systems Serving Multiple Dwelling Units	New	This paragraph requires any building mechanical system or service water heater serving more than one dwelling unit must use the commercial code.
	403.8	Snow Melt System Controls	New	This paragraph requires snow melt system tied to the building systems to have an automatic control system.
	403.9	Pools	New	This paragraph creates energy conservation measures for pools
	403.9.1	Pool Heaters	New	This paragraph requires on-off switch for shutting off the heater. Pool heaters fired by natural gas or LPG shall not have continuously burning pilot.
	403.9.2	Time Switches	New	This paragraph requires pool equipment to run off of an automatic timer.
	403.9.3	Pool Covers	New	This paragraph requires heated pools to have an insulated cover.
Section 404	404.1	Lighting Equipment	New	This paragraph requires 50% of the lighting fixtures to require high-efficiency lamps.
Section 404		Simulated Performance Alternative	Relocated	This section is now Section 405

Appendix A.1 – IECC Code Comparison from the 2006 Edition to the 2009 Edition

Section	Paragraph Title	Heading	Revision Type	Comment
	404.2	Mandatory Requirements	Revised	This Section is now 405.2. The revision requires compliance with the paragraph 401.2 and any duct work outside the envelope shall have an R-6 Insulation Value.
	404.3	Performance Based Compliance Exception	Revised	This section is now Section 405.3. The revision allows Btu or Btu per square feet of condition floor area to be substituted for energy cost.
	404.4.2	Compliance Report	Revised	This section is now Section 405.4.2. The revision requires the proposed design to comply with paragraph 405.3.
	404.4.2	Compliance Report Subparagraph 2	Revised	This section is now Section 405.4.2. The revision will require the documentation for the standard reference design and the proposed reference design to include all of the inputs.
	404.4.3	Additional Documentation	Revised	This section is now Section 405.4.3. The revision requires (if requested by the Building Official) documentation of the actual values used in the software calculations for the proposed design.
	Table 404.5.2(1)	Specifications for the Standard Reference and Proposed Design	Relocated/Revised	This table is now Table 405.5.2(1). The Table revised the following 1) Glazing - reduce percentage of glazing area from 18 percent to 15 percent 2) Heating Systems - Deletes fuel types for electric, non-electric furnaces and non-electric boilers. 3) Cooling System- Deletes efficiency compliance with Federal Standards 4) Service Water Heating - Deletes requirements for standard references. The proposed design will also be the standard design. 5) Thermal Distribution Systems - The equipment efficiency was changed from .80 to .88. The Table now includes a standard reference for duct work, either insulated or tested. 6) Thermostat - The cooling set point was changed from 78% to 75%. The heating set point was changed from 68% to 62%. See Section C for Table.

Section	Paragraph Title	Heading	Revision Type	Comment
	Table 404.5.2(2)	Default Distribution System Efficiencies for Proposed Design	Relocated/Revised	This table is now Table 405.2(2). The revisions are as follows: 1) Forced air system components - deletes value for forced air system 2) Deletes" Proposed Reduced Leakage for Systems Located within Conditioned Space". 3) Deletes "Proposed Reduced Leakage for Components Located Outside the Conditioned Space". See Section C for Table

Section	Paragraph Title	Heading	Revision Type	Comment
Chapter 5 - Commercial Energy Efficiency				
	502.1.1	Insulation and Fenestration Criteria	Revised	The revision allows for any part of the building with a Group R occupancy to use the R-Value from the Group R column of Table 502.2(1)
	502.1.2	U-Factor Alternative	New	This paragraph allows an assemble with a U-Factor, C-Factor or F-Factor equal to or less than Table 502.1.2 as an alternate approach for commercial and Group R buildings.
	502.2.6	Floors Over Outdoor Air or Conditioned Space	Revised	The revision changes the weighted material definition for "Mass Floors" from 120 pounds to 12 pounds per cubic foot.
	502.4.8	Recessed Lighting	Revised	The revision deletes the options for recessed luminaries in the thermal envelope. All such luminaries shall be IC-rated labeled as meeting ASTM 283.
	502.5	Moisture Control	Deleted	
	Table 502.1.2	Building Envelope Requirements Opaque Element, Maximum U-Factors	Revised	This Table provides the U-Factors for building elements for the alternate approach per paragraph 502.1.2. See Section B for table.
	Table 502.2(1)	Building Envelope Requirements - Opaque Assemblies	Revised	The revision changes the insulation values required for building elements. See Section C for table. See Section - B.1 for narrative on envelope narrative.
	Table 502.2(3)	Building Envelope Requirements - Opaque Assemblies	Revised	The revision changes the insulation requirements and the references. See Section C for Table. See Section - B.2 for insulation narrative.
	Table 502.3	Building Envelope Requirements - Fenestration	Revised	The revision changes the U-Factors listed for comments and deletes plastics. See Section C for Table.
Section 503	503.2.1	Calculations of Heating and Cooling Loads	Revised	The revision changes the ASHRAE/ACCA reference standard from fundamentals handbook to standard 183.
	503.2.3	HVAC Equipment Performance Requirements, Exception	Revised	The revision changes the requirements for water-cooled centrifugal water-chilling package. It also adds performance requirements for chillers designed to operate outside of the stated ranges.
	503.2.4.5	Snow Melt System Controls	New	This paragraph provides the automatic controls requirements for snow melting system tied into the building system.

Section	Paragraph Title	Heading	Revision Type	Comment
	503.2.5.1	Demand Controlled Ventilation	New	This paragraph requires a demand control ventilation for spaces larger than 500 square feet with an average occupant load of 40 people per 1,000 square feet.
	503.2.6	Energy Recovery Ventilation Systems Exceptions	Revised	The revision deletes exception #2 regarding laboratory fume hoods
	503.2.7	Duct and Plenum Insulation and Sealing	Revised	This revision changes the sealing requirements in the second paragraph. The new requirement refers to Section 603.9 of the International Mechanical Code. This Section requires ducts to be constructed as per SMACNA HVAC duct construction standards. The Section also requires all joints to be constructed per listed and UL Labeled standards.
	503.2.8	Piping Insulation Exceptions	Revised	The revision adds an exception for piping in room fan-coils and unit ventilators.
	503.2.9.1	Air System Balancing	Revised	The revision changes the horsepower requirement from 25 hp to 10 hp
	503.2.10	Air System Design and Control	New	This paragraph establishes requirements for HVAC fans that are over 5 horsepower
	503.2.10.1	Allowable Fan Floor Horsepower	New	This paragraph sets limits for fan system design conditions based on the horsepower listed on the fan nameplate
	Table 503.2.10.1(1)	Fan Power Limitation	New	See Section C for Table
	Table 503.2.10.1(2)	Fan Power Limitation Pressure Drop Adjustment	New	See Section C for Table
	503.2.10.2	Motor Nameplate Horsepower	New	This paragraph limits fan motor size based on fan break power
	503.2.11	Heating Outside a Building	New	This paragraph requires heating system outside the building to be a radiant system.
	503.4.3.3.1	Temperature Dead Band	Revised	The revision deletes the requirements for systems in Climate Zones 3 through 8
	503.4.3.3.2	Heat Rejection	New	This paragraph adds requirements for heat rejection equipment
	503.4.3.3.2.1	Climate Zones 3 and 4	New	This paragraph adds requirements for heat rejection for open-

Section	Paragraph Title	Heading	Revision Type	Comment
				circuit and close-circuit cooling towers.
	503.4.3.3.2.2	Climate Zones 5 Through 8	New	This paragraph adds requirements for an open or closed loop cooling tower to have a separate heat exchanger.

Section	Paragraph Title	Heading	Revision Type	Comment
	503.4.3.3.3	Two Position Valve	New	This paragraph requires a two-position valve for a pump that exceeds 10 horsepower on a hydronic heat pump.
	503.4.5.4	Supply-Air Temperature Reset Controls	New	This paragraph adds requirements for multiple zone HVAC system controls
	503.4.7	Hot Gas Bypass Limitation	New	This paragraph places limitations on how cooling system can use hot gas bypass or evaporator pressure control systems.
	Table 503.4.7	Maximum Hot Gas Bypass Capacity	New	This Table lists the maximum hot gas bypass capacities. See Section C for Table
	Table 503.2.3(2)	Unitary Air Conditioners and Condensing Units, Electrically Operated, Minimum Efficiency Requirements	Revised	The revisions change the minimum efficiency requirements for equipment listed. The table adds requirements for through-the-wall equipment. See Section C for Table.
	Table 503.2.3(5)	Boiler, Gas and Oil-Fired, Minimum Efficiency Requirements	Revised	The revision adds a value for conservation efficiency. See Section C for Table.
	Table 503.2.3(7)	Water Chilling, Efficiency Requirements	Revised	The Table was completely revised. The new Table changes the efficiency values, and provides requirements for two compliance paths. See Section C for Table.
	Table 503.2.3(8)	Cop's and Plv's for Non-Standard Centrifugal Chillers 150 Tons	Deleted	
	Table 503.2.3(9)	COP's and PLV's for Non-Standard Centrifugal Chillers > 150 Tons < 300 Tons	Deleted	
	Table 503.2.3(10)	COP's and IPLV's for Non-Standard Centrifugal Chillers > 300 Tons	Deleted	
	Table 503.2.3(11)	Performance Requirements for Heat Rejection Equipment	Deleted	
	Table 503.2.8	Minimum Pipe Insulation	Revised	The revision changes the minimum pipe insulation from 1 to 1.5.
	Table 503.3.1(1)	Economizer Requirements	Revised	The revision changes the requirements for climate zones 5A and 6A. See Section C for Table
Section 504				
Section 505	505.1	General Exception	Revised	The revision changes the exception to include 50 percent or more of the permanently installed interior light fixtures for dwelling units.
	505.2.2.3	Daylight Zone Control	New	This paragraph requires lighting control in the daylight zone separate from the general area lighting. See Section - B.4 for narrative on daylight zones.

Section	Paragraph Title	Heading	Revision Type	Comment
	504.2.4	Exterior Lighting Controls	Revised	The revision names the type of lighting controls for lighting not required for dusk to dawn operation
	505.5.1	Total Connected Interior Lighting Power, Exceptions	Revised	The revision deletes exceptions for special research lighting and display lighting. The revision adds exceptions for occupied spaces with medical issues and historic landmarks.
	505.5.1.4	Line-Voltage Lighting Track and Plug-In Busway	Revised	The revision changes the requirements.
	505.6.2	Exterior Building Lighting Power	Revised	The revision adds requirements for lighting zones per Table 505.6.2(1)
	Table 505.6.2(1)	Exterior Lighting Zones	New	This Table defines the lighting zones to determine lighting descriptions. See Section C for Table
	Table 506.2(2)	Individual Lighting Power Allowances for Building Exteriors	Revised	The Table was revised to determine lighting power allowance per exterior lighting zones.
Section 506		Total Building Performance	Revised	This Section has been completely changed to allow for an alternate compliance path. See Section - B.3 for energy model narrative.
	506.1	Scope	New	The paragraph establishes criteria for an alternate compliance base on total building performance
	506.2	Mandatory Requirements	New	The paragraph requires compliance with certain Sections
	506.3	Performance-Based Compliance	New	This paragraph allows for compliance based on comparison of annual energy rate of a standard reference design versus a prepared design.
	506.4	Documentation	New	This paragraph lists reporting documentation.
	506.4.1	Compliance Report	New	This paragraph allows for software tools to provide the documentation. It also establishes the minimum documents required.
	506.4.2	Additional Documentation	New	This paragraph identifies additional documentation that a code official is permitted to request.
	506.5	Calculation Procedure	New	This paragraph establishes the configuration and analysis method for both the standard reference and the proposed design.
	506.5.1	Building Specifications	New	This paragraph establishes the building component specification values for both the standard reference and the proposed design.

Section	Paragraph Title	Heading	Revision Type	Comment
	506.5.2	Thermal Blocks	New	This paragraph provides the requirements for thermal blocks.
	Table 506.5.1(1)	Separation for the Standard Reference and Proposed Design	New	This Table provides the value to be used in the calculations for the standard reference and proposed design. See Section C for Table.
	Table 506.5.1(2)	HVAC System Map	New	This Table provides HVAC systems for the standard reference design. See Section C for Table.
	Table 506.5.1(3)	Specification for the Standard Reference Design HVAC System Descriptions	New	This Table provides the system description for HVAC systems used in the standard reference and the proposed design. See Section C for Table.
	Table 506.5.1(4)	Number of Chillers	New	This Table provides guidance on chiller sizing for the standard reference. See Section C for Table.
	Table 506.5.1(5)	Water Chiller Types	New	This Table provides guidance on chiller sizing for the standard reference. See Section C for Table.
	506.5.2.1	HVAC Zones Designed	New	This paragraph provides guidance on modeling HVAC zones
	506.5.2.2	HVAC Zone Not Designed		This paragraph and subparagraphs provide guidance for HVAC zones not designed.
	506.5.2.3	Multi-Family Residential Buildings	New	This paragraph defines how residential units are to be calculated.
	506.6	Calculation Software Tools	New	This paragraph and subparagraph establishes the requirements for the capabilities of software tools.
	506.6.1	Specific Approval	New	This paragraph adds additional requirements of performance analysis tools
	506.6.2	Input Values	New	This paragraph requires that all input values be taken from an approved source.

Appendix A.1 – IECC Code Comparison from the 2006 Edition to the 2009 Edition

Section	Paragraph Title	Heading	Revision Type	Comment
Chapter 6 - References				
	ASHRAE	119-88	Revised	This reference was revised to the 2004 Edition
	ASHRAE	140-2007	New	
	ASHRAE	Standard 183-2007	New	
	ASHRAE	13256-1	Revised	This reference was revised to the 2005 Edition
	ASHRAE	90.1	Revised	This reference was revised to the 2007 Edition
	ASHRAE	Handbook of Fundamentals	Revised	This reference was revised to the 2005 Edition
	ASTM	E 96 00 01	Deleted	
	ASTM	C-90	Revised	This reference was revised to the 2006b Edition
	CSA	101/I.S.2/A440		This reference was revised to the 2008 Edition
	CTI	ATC-105	Deleted	
	CTI	STD-201	Deleted	
	ICC	IBC, IFC, IFGC, IMC, IPL, IRL	Revised	These references were revised to the 2009 Edition
	IESNA	90.1	Revised	This reference was revised to the 2007 Edition
	NFRC	100, 200, 400	Revised	These references were revised to the 2004 Edition
	UL	181A-98, 181B-95	New	
	LL	727	Revised	This reference was revised to the 2006 Edition
	US-FTC	CFR Title 16	New	
	LUDMA	101/I.S.2/A446	Revised	This reference was revised to the 2008 Edition

A.2 – IECC Code Comparison from the 2009 to the Proposed 2012 Edition

International Energy Conservation Code Comparison
2009 Edition to 2012 Draft Edition

Section	Paragraph Title	Heading	Revision Type	Comment
Chapter 1		Administration		No data available for comparison
Chapter 2		Definitions		No data available for comparison
Chapter 3		Climate Zones		No data available for comparison
Chapter 4 - Residential Energy Code				
	401.2	Compliance	Revised	This revision deletes the section references. It now states the sections noted as mandatory must be complied with in either the prescriptive or performance path.
	401.3	Certification	Revised	The revision makes this a mandatory requirement. It also requires that the results from any required duct system and building envelope air leakage test be listed on the certificate.
Section 402	402.1	General	Revised	The revision requires the building envelope to comply with Section 402.1.1 through 402.1.4.
	402.2	Specific Insulation Requirements	Revised	The revision requires compliance with Section 402.2.1 through 402.2.12
	402.2.3	Attic Baffle	New	This paragraph adds requirements for cove baffles at attic insulation.
	402.2.3	Access Hatches and Weeps	Relocated	This section is now Section 402.2.4
	402.2.4	Mass Walls	Relocated	This section is now Section 402.2.5
	402.2.5	Steel Frame Ceilings, Walls and Floors	Relocated/Revised	This section is now Section 402.2.6. The exception for climate zones 1 and 2 has been deleted.
	402.2.6	Floors	Relocated	This section is now Section 402.2.7
	402.2.7	Basement Walls	Relocated	This section is now Section 402.2.8
	402.2.8	Slab-On-Grade Floors	Relocated	This section is now Section 402.2.9
	402.2.9	Crawl Space Walls	Relocated	This section is now Section 402.2.10

A.2 – IECC Code Comparison from the 2009 to the Proposed 2012 Edition

Section	Paragraph Title	Heading	Revision Type	Comment
	402.2.10	Masonry Veneer	Relocated	This section is now Section 402.2.11
	402.2.11	Sunroom Insulation	New	This paragraph provides the requirements for sunrooms surrounding conditioned spaces with exceptions.
	402.3	Fenestrations	Revised	The revision requires the fenestrations to comply with Sections 402.3.1 through 402.3.6
	402.3.5	Thermally Insulated Sunroom U-Factor	Replaced	This paragraph requires sunrooms enclosing condition space to meet the fenestration portion of the code with exceptions. Sunroom fenestrations shall comply with Table 402.1.1 and 402.1.3. For sunrooms in climate zones 4 and above, the U-Factor shall be 0.45 for sunroom skylighting in climate zones 4 and above the U-Factor shall be .70.
	402.4.1	Building Thermal Envelope	Revised	The revision indicates the building thermal envelope shall comply with Sections 402.4.1.1 and 402.4.1.2. It also deletes the list of components that are to be sealed.
	402.4.1.1	Installation	New	This paragraph provides the installation requirements for building thermal envelope components. See Section - B.1.
	Table 402.4.1.1	Air Barrier and Insulation Installation	New	This Table lists envelope components and installation criteria.
	402.4.1.2	Testing	New	This paragraph requires the building envelope to be tested to verify air leakage. The test should be a blower door test. The paragraph also provides the criteria values for the test. See Section - B.1.
	402.4.2	Air Sealing and Insulation	Deleted	
	402.4.2.1	Testing Option	Deleted	
	402.4.2.2	Visual Inspection Option	Deleted	
	402.4.3	Fireplaces	Revised	This revision adds a requirement to the flue to have a tight-fitting damper.
	402.4.5	Recessed Lighting	Revised	This revision changes the label requirements from meeting ASTM E 253 to having an air leakage rate of not more than 2.0 cfm when tested to ASTM E 283.
	Table 402.1.1	Insulation and Fenestration Requirements by Component	Revised	The revision changes the values for components.

A.2 – IECC Code Comparison from the 2009 to the Proposed 2012 Edition

Section	Paragraph Title	Heading	Revision Type	Comment
	Table 402.1.3	U-Factor Alternative	Revised	The revisions change the values for components.
	Table 402.2.6	Steel-Frame Ceiling, Wall, and Floor Insulation (R-Value)	Revised	The revision changes the insulation values for steel studs.
	Table 402.4.1.1	Air Barrier and Insulation Installation	Revised	The revision changes the criteria for air barrier of each component.
Section 403	403.2	Ducts	Revised	The revision adds the requirement for ducts to comply with Section 403.2.1 through 403.2.4.
	403.2.2	Sealing	Revised	The revision deletes the paragraph and replaces it with the requirement to reference Section 603.9 of the International Mechanical Code with exceptions. Section 603.9 of the IMC requires all duct work to be sealed per SMACNA and UL guidelines. The revision also provides two methods for testing duct tightness.
	403.2.2.1	Sealed Air Handler	New	This paragraph requires air handlers to have an air leakage of not more than 2 percent of the design air flow rate.
	403.2.5	Building Cavities	New	This paragraph does not allow framing cavities to be used as a plenum or for ducts. This paragraph is mandatory.
	403.3.1	Protection of Piping Insulation	New	This paragraph requires any pipe insulation exposed to weather to be protected.
	403.4	Circulating Hot Water Systems	Revised	The revision deletes the criteria and replaces it with having the system comply with Sections 403.4.1 and 403.4.2.
	403.4.2	Hot Water Piping Insulation	New	This paragraph lists the types of pipe to be insulated and the insulation R-Value.
	Table 403.4.2	Maximum Run Length	New	Provides criteria for the run length of hot water piping
	403.5	Mechanical Ventilation	Revised	The revision deletes the reference to dampers and replaces it with a reference to comply with M1507 International Residential Mechanical Code.
	403.5.1	Whole-House Mechanical Ventilation System for Efficiency	New	This paragraph references the requirements for a whole-house ventilation system to Section M1507 of the International Residential Code.
	Table 403.5.1	Mechanical Ventilation System Fan Efficiency	New	This Table provides the requirements for air flow rates, and fan efficiency.
	403.6	Equipment Size	Revised	The revision deletes the reference to Section M1401.3 of the International Residential Code and replaces it with a reference to comply with ACCA Manual S for Equipment Size, based on ACCA Manual J calculations.

A.2 – IECC Code Comparison from the 2009 to the Proposed 2012 Edition

Section	Paragraph Title	Heading	Revision Type	Comment
	403.9	Pools	Revised	The revision expands the requirements to permanently installed spas.
	403.9.1	Heaters	Revised	The revision adds a requirement to locating the heater shut off
	403.9.2	Time Switches	Revised	The revision allows for heaters, pumps and motors to have built-in timers.
	403.9.3	Covers	Revised	The revision extends the requirements to permanently installed spas. The exception revises the percent of the site-recovered or solar energy for heating from 60 percent to 70 percent. It also adds the requirement for the percentage to be calculated seasonal.
Section 404	404.1	Lighting Equipment	Revised	The revision changes the percentage of permanently installed high-efficacy lamps from 50 percent to 75 percent. It also adds an exception for low voltage lamps.
	404.1.1	Lighting Equipment	New	This paragraph provides a requirement for fueled gas lighting.
Section 405	405.4	Documentation	Revised	The revisions requires compliance to Sections 405.1.1 through 405.4.3.
	405.5	Calculation Procedure	Revised	The revision requires compliance with Sections 405.5.1 and 405.5.2.
	405.6	Calculation Software Tools	Revised	The revision requires compliance with Sections 405.6.1 through 405.6.3.
	405.6.1	Minimum Capabilities Subparagraph #2	Revised	The revision changes the reference standard from M1401.3 of the International Residential Code to Section 403.6 which requires equipment to be sized per ACCA Manual S based on ACCA Manual J calculations.
	Table 405.5.2(1)	Specifications for the Standard Reference and Proposed Designs	Revised	The revision changes the standard reference for glazing, air exchange rate, heating systems and thermal distribution systems.

A.2 – IECC Code Comparison from the 2009 to the Proposed 2012 Edition

Section	Paragraph Title	Heading	Revision Type	Comment
Chapter 5 - Commercial Energy Efficiency				
Section 501	501.1	Scope	Revised	The revision deletes the reference for commercial buildings to meet ANSI/ASHRAE/ESNA Standard 90.1
	501.2	Application	Revised	The revision adds a requirement for commercial buildings to comply with Sections 506.2, 506.3 or 506.4.
	501.2.1	Application to Existing Buildings	New	This paragraph adds a requirement for additions, alterations and building repairs to comply with Sections 502, 503, 504, and 505 or ANSI/ASHRAE/IESNA 90.1.
Section 502	502.1	General	Revised	The revision requires the building thermal envelope to comply with Section 502.1.1. It also allows compliance with Section 502.1.2 as an alternative for R-Values.
	502.1.1	Insulation and Fenestration Criteria	Revised	The revision changes the Table reference from 502.2(1) to 502.2.
	502.2	Specific Insulation Requirements	Revised	The revision changes the Table reference from 502.2(1) to 502.2. The revision also adds requirements for the installation for multi-layers of continuous insulation board.
	502.2.1	Roof Assembly	Revised	The revision changes the Table reference from 502.2(1) to 502.2. It also requires skylight curbs to be insulate to a minimum of R-5.
	502.2.1	Roof Assembly Exception #1	Revised	The revision changes the Table reference from 502.2(1) to 502.2.
	502.2.1	Roof Assemblies Exception #2	New	This paragraph allows skylight curbs as a component of an NFRC 100 rated assembly does not need to be insulated.
	502.2.1.1	Roof Solar Reflectance and Thermal Emittance	New	This paragraph requires low sloped roofs over conditioned spaces in climate zones 1, 2, and 3. To comply with Table 502.2.1.1 minimum roof reflectance and emittance options. The paragraph has exceptions for portions of the roof that are covered, shaded, ballasted. It also exempts roof that have 75 percent coverage, shade or ballast.
	Table 502.2.1.1	Minimum Roof Reflectance and Emittance Options	New	The Table provides the reflectance or emittance requirements for a low slope roof.
	502.2.3	Thermal Resistance of Above-Grade Walls	Revised	The revision changes the Table reference from 502.2(1) to 502.2.

A.2 – IECC Code Comparison from the 2009 to the Proposed 2012 Edition

Section	Paragraph Title	Heading	Revision Type	Comment
	502.2.5	Floors Over Outdoor Air or Unconditioned Space	Revised	The revision changes the Table reference from 502.2(1) to 502.2.
	502.2.6	Slabs On Grade	Revised	The revision changes the Table reference from 502.2(1) to 502.2. The revision also adds a requirement for insulation extending away from the building. It also provides an exception for slabs that are 24 inches below finish grade.
	502.2.7	Opaque Doors	Revised	The revision changes the Table reference from 502.2(1) to 502.2.
	502.2.8	Insulation of Radiant Heating System	New	This paragraph requires a R-3.5 insulation value for radiant heating system used at the floor.
	502.3	Fenestration	Revised	The revisions adds a requirement for automatic daylighting controls to comply with 505.2.2.3.2.
	502.3.1	Maximum Area	Revised	This revision deletes the references to Table 502.3 and now limits the vertical fenestration area to 30 percent of the gross above grade wall area. Reduced from 40 percent.
	502.3.1.1	Increased Vertical Fenestration Area with Daylighting Controls	New	This paragraph allows for the vertical fenestration from 30 percent to 40 percent in climate zones 1 through 6 provided that no less than 50 percent of the floor area is in a daylight zone, automatic daylight controls are added, and the visible light transmittance is greater than or equal to 1.1 times the solar heat gain coefficient.
	502.3.1.2	Increased Skylight Area with Daylight Controls	New	This paragraph allows skylights for up to 5 percent of the roof provided automatic daylighting controls are installed.
	502.3.2	Minimum Skylight Fenestration Area	New	This paragraph provides the minimum skylight area for skylights for particular building types.
	502.3.2.1	Lighting Controls in Daylight Zones Under Skylights	New	This paragraph provides the requirements for lighting controls in daylighting zones.
	502.3.2	Maximum U-Factor and SHGC	Relocated/Revised	This paragraph is now 502.3.2. It also adds the evaluation criteria for glass doors and windows with different PF values.
	502.3.3.1	SHGC Adjustments	New	This paragraph allows for a change in the SHGC for windows protected with an overhang.
	Table 502.3.3.1	SHGC Adjustment Multipliers	New	This Table provides a multiplier for adjusting the SHGC value for windows under protections.

A.2 – IECC Code Comparison from the 2009 to the Proposed 2012 Edition

Section	Paragraph Title	Heading	Revision Type	Comment
	502.3.3.2	Increased Vertical Fenestration SHGC	New	This paragraph sets the SHGC for windows that are 6 feet above the floor for climate zones 1 through 6.
	502.3.3.3	Increased Skylight SHGC	New	This paragraph sets the SHGC for skylights with an automatic daylight controls at .60, for climate zones 1 through 6.
	502.3.3.4	Increased Skylight U-Factor	New	This paragraph sets the U-Factor for skylights with automatic daylight controls at .9, for climate zones 1 through 3 and .75 for climate zones 3 through 8.
	502.3.3.5	Dynamic Glazing	New	This paragraph provides the requirements for windows and doors with dynamic glazing. Dynamic glazing is any glazing that can change its performance properties with a controlling device. Windows with adjustable shades in the glazing air space is an example.
	502.3.4	Area-Weighted U-Factor	New	This paragraph allows for an alternative to the U-Factor from Table 502.3 based on an area-weighted average.
	502.4.1	Air Leakage	Revised	The revision requires air leakage to comply with Sections 502.4.4 through 502.4.8.
	502.4.1.1	Air Barrier	New	This paragraph adds requirements that all buildings except those in climate zones 1, 2, and 3 to have a continuous air barrier throughout the building envelope. The air barrier shall comply with Sections 502.4.1 through 502.4.8.
	502.4.1.2	Air Barrier Compliance Options	New	This paragraph allows for the air barrier to comply with Sections 502.4.1.2.1, 502.4.1.2.2 or 502.4.1.2.3.
	502.4.1.2.1	Materials	New	This paragraph indicates materials with an air permeability no greater than 0.0.24s-m^2 under a pressure differential of 75 Pa when tested to ASTM E2178 shall be considered an air barrier. The paragraph also lists materials that comply. See Section - B.1.
	502.4.1.2.2	Assemblies	New	This paragraph provides the air leakage requirement for assemblies.
	502.4.1.2.3	Building Test	New	This paragraph requires the building envelope be tested. The air leakage shall not exceed 2.06/s-m^2 at 75 Pa at a pressure differential of .3 in accordance with ASTM E779. See section - B.1.
	502.4.2	Curtain Wall Storefront Glazing and Commercial Entrance Doors	Deleted	This section is replaced by 502.4.2 Air Barrier Penetrations

A.2 – IECC Code Comparison from the 2009 to the Proposed 2012 Edition

Section	Paragraph Title	Heading	Revision Type	Comment
	502.4.2	Air Barrier Penetrations	New	This paragraph requires penetration of the air barrier to be sealed with appropriate materials for components being sealed.
	502.4.3	Sealing of the Building Envelope	Deleted	This paragraph is deleted and replaced by 502.4.3 Air Leakage of Fenestration.
	502.4.3	Air Leakage of Fenestration	New	This paragraph requires fenestration to have a leakage requirement per Table 502.4.3. It also requires that the fenestration be tested by a third party laboratory and labeled.
	Table 502.4.3	Maximum Air Infiltration Rate for Fenestration Assemblies	New	The Table provides the maximum air leakage rate and the testing procedures for fenestration requirements.
	502.4.4	Doors and Access Openings to Shafts, Chutes, Stairways and Elevator Lobbies	New	This paragraph requires doors to comply with Section 502.4.3 or be gasketed, weather-stripped or sealed, doors required to comply with International Building Code Section 715 or 715.4 or UL 1784 are not required to comply.
	502.4.5	Outdoor Air Intakes and Exhaust Openings	Deleted	This paragraph is deleted and replaced by 502.4.5 Air Intakes Exhaust Openings, Stairways and Shafts.
	502.4.5	Air Intakes, Exhaust Openings, Stairways and Shafts	New	This paragraph requires that any air intakes or exhaust have dampers in compliance with Section 502.4.1 and 502.4.2.
	502.4.5.1	Stairways and Shaft Vents	New	This paragraph requires (where vents are required in) stair and elevator shafts be provided with a Class 1 motorized dampers with a maximum air leakage of 4 cfm per square feet at 1.0 inch water gauge. The dampers shall have automatic controls that opens damper with power interruptions or fire alarm activation.
	502.4.5.2	Outdoor Air Intakes and Exhaust	New	This paragraph requires outdoor supply and exhaust to have the same Class 1 motorized dampers as listed in Section 502.4.5.1. The exceptions allow the use of gravity dampers with a maximum air leakage rate of 20 cfm per square foot. The exception applies to relief dampers in buildings three stories in height, ventilation intakes and exhaust in climate zones 1, 2, and 3 and in buildings where the intake or exhaust does not exceed 300 cfm. The exception also allows dampers smaller than 24 inches in either dimension to have a leakage of 40 cfm per square foot.

A.2 – IECC Code Comparison from the 2009 to the Proposed 2012 Edition

Section	Paragraph Title	Heading	Revision Type	Comment
	502.4.7	Vestibules	Revised	The revision changes the requirement to separate conditioned spaces from the exterior to all building entrances to be protected by an enclosed vestibule. Exception #2 changes the exemption from door not intended as a building entrance to door not intended for public use.
	Table 502.1.2	Opaque Thermal Envelope Assembly Requirements	Revised	The table revises the U Values.
	Table 502.2(2)	Building Envelope Requirements - Opaque Assemblies	Deleted	
	Table 502.3	Building Envelope Requirements: Fenestration	Revised	The table was revised to delete framing materials and is replaced by U-Factor for type of penetration, SHGC value for vertical fenestrations and skylights.
Section 503	503.2	Provisions Applicable to all Mechanical Systems	Revised	The revision requires mechanical systems to comply with Sections 503.2.1 and 503.2.11.
	503.2.1	Calculation of Heating and Cooling Loads	Revised	The revision requires the design loads to account for the building envelope, lighting, ventilation and occupancy loads.
	503.2.2	Equipment and System Sizing	Revised	The revision changes the reference of equipment sizing to output capacity.
	503.2.3	HVAC Equipment Performance Requirements	Revised	The revisions adds the requirements found in Tables 503.2.3(1) through 503.2.3(8). It also adds a requirement for plate type liquid to liquid heat exchangers based on Table 503.2.3(9).
	503.2.3	HVAC Equipment Performance Requirements Exception	Deleted	This exception is replaced by Section 503.2.3.1 Water-Cooled Centrifugal Chilling Packages.
	503.2.3.1	Water-Cooled Centrifugal Chilling Packages	New	This paragraph provides design requirements for chillers not designed for operation at AHRI Standard 550/590.
	503.2.3.2	Positive Displacement (Air and Water-Cooled) Chilling Packages	New	This paragraph provides requirements for chillers with a leaving fluid temperature higher than 32 degrees F.
	Table 503.2.3(9)	Heat Transfer Equipment	New	The table provides values for and testing procedures for heat exchangers.
	503.2.4.3.3	Automatic Start Capabilities	New	This paragraph provides requirements for HVAC controls. The controls shall be capable of adjusting daily start times to bring spaces to the desired temperature prior to occupancy.
	503.2.5.1	Demand Controlled Ventilation	Revised	The revision changes the average occupant load from 40 people to 25 people per 1,000 square feet.

A.2 – IECC Code Comparison from the 2009 to the Proposed 2012 Edition

Section	Paragraph Title	Heading	Revision Type	Comment
	503.2.5.1	Demand Controlled Ventilation Exceptions	Revised	The revision adds exception #5 for ventilation provided for process loads only.
	503.2.6	Energy Recovery Ventilation Systems	Revised	The revision changes the threshold on requiring an energy recovery system from 5000 cfm or greater and a minimum outside air supply of 70 percent to the values listed in Table 503.2.6.
	503.2.6	Energy Recovery Ventilation System, Exceptions	Revised/New	Exception #5 was changed to exempt heat recovery system from climate zone 1 and 2. Exception #6 changes to exempt cooling recovery system from climate zones 3c, 4c, 5b, 5c, 6b, 7 and 8. Exception #7 changes to exempt systems requiring dehumidification that employ energy recovery in series with the cooling coil. Exception #8 adds exemptions where the largest source of air exhaust at a single location is less than 75 percent of the outdoor air flow rate. Exception #9 adds an exemption where the systems operate less than 20 hours per week.
	Table 503.2.6	Energy Recovery Requirement	New	The table provides design values for requiring an energy recovery requirement. See Section C for Table
	503.2.8	Piping Insulation Exceptions	Revised	Exception #3 changes the operating temperature from 55 digress F to 60 degrees F. Exception #5 is deletes run out piping and replaces by strainers, control valves and balancing values associated with piping 1 inch or less in diameter. Exception #6 adds an exemption for direct buried piping with fluids at or below 60 degrees F.
	503.2.8.1	Protection of Piping Insulation	New	This paragraph requires piping insulation to be protected.
	503.2.9	HVAC Systems Completion	Deleted	The paragraph is replaced by 503.2.9 Mechanical Systems Commissioning and Completion Requirements.
	503.2.10.1	Allowable Fan Floor Horsepower	Revised	The revision adds a requirement for single zone variable air volume systems to comply with the constant volume fan power limitation.
	503.2.10.1	Allowable Fan Floor Horsepower Exceptions	Revised	Exception #1 adds a vivarium to the list of spaces. Exception #3 was deleted.
	503.3	Simple HVAC Systems and Equipment	Revised	The second paragraph was deleted.
	503.3.1	Economizers	Revised	The revision changes the design requirement for economizers from Table 503.3.1(1) to complying with Sections 503.3.1.1 through 503.4.1.4.

A.2 – IECC Code Comparison from the 2009 to the Proposed 2012 Edition

Section	Paragraph Title	Heading	Revision Type	Comment
	503.3.1	Economizers Exceptions	Revised/New	Exceptions #1 and #2 have been deleted and replaced with exception #1 Exempting Individual Fan-Cooling Units and exception #2 exempting Systems Designed to Humidify Space Above 35 digress F. Exception #3 exempts systems that serve residential spaces with a capacity of less than five times the requirement from Table 503.3.1(1). Exception #4 systems operating less than 20 hours a week. Exception #5 exempts systems using outdoor air for cooling that will effect supermarket refrigerated casework systems. Exception #6 exempts systems that meet or exceed the efficiency values from Table 503.3.1(2).
	503.3.1.1	Air Economizers	New	This paragraph adds a requirement for air economizers to comply with Section 503.1.1.1 through 503.1.1.4.
	503.3.1.1.1	Design Capacity	New	The paragraph requires air economizers to be able to supply 100 percent of the design supply air for cooling.
	503.3.1.1.2	Control Signal	New	This paragraph requires economizers to be sequenced with the mechanical cooling equipment with the exception allowing use of mixed air temperature limit control for systems controlled from space temperatures.
	503.3.1.1.3	High-Limit Shut Off	New	The paragraph requires the economizer controls to reduce the outdoor air intake to the design minimum outdoor air quantity when intake will no longer reduce cooling energy. The paragraph sets control types for climate and settings per Table 503.1.1.3(2).
	Table 503.3.1.1.3(1)	High-Limit Shut Off Control Options for Air Economizers	New	This Table establishes control types based on climate zones.
	Table 503.3.1.1.3(2)	High-Limit Shut Off Control Settings for Air Economizers	New	This Table provides the set points for device types and climate.
	503.3.1.1.4	Relief of Excess Outdoor Air	New	This paragraph requires the system to be capable of relieving excess outdoor air during economizer operations.
	503.4.1	Economizer	Revised	The revision changes the design requirement from Table 503.3.1(1) to comply with Section 503.4.1.1 through 503.4.1.4. The revision also deletes the exceptions.

A.2 – IECC Code Comparison from the 2009 to the Proposed 2012 Edition

Section	Paragraph Title	Heading	Revision Type	Comment
	503.4.1.1	Design Capacity	New	This paragraph requires water economizers to be able to cool supply air by indirect evaporation and provide up to 100 percent of the expected cooling load at outdoor air temperatures of 50 degrees F dry bulb. The exception allows the cooling load to be 45 degrees F dry bulb at systems with dehumidification requirements.
	503.4.1.2	Maximum Pressure Drop	New	This paragraph provides design requirements for pre-cooling coils and water-to-water heat exchangers to have a water side pressure drop of less than 15 feet of water or have a secondary loop where the pressure drop is not seen by the circulation pumps.
	503.4.1.3	Integrated Economizer Control	New	This paragraph requires systems to be integrated with mechanical cooling system and provide partial cooling. The exceptions exclude direct expansion systems to prevent frost and individual direct expansion systems with non-integrated controls that preclude simultaneous operation of the economizer and mechanical cooling.
	503.4.1.4	Economizer Heating System Impact	New	This paragraph requires economizer controls to prevent increase building heat energy when the economizer is in operation. The exception exempts economizers on VAV systems that cause zone level heating to increase due to a reduction in supply air temperature.
	503.4.2	Variable Air Volume (VAV) Fan Control	Revised	The revision changes the motor horsepower from 10 to 7.5. Subparagraph #2 was renamed to #3. Subparagraph #2 now reads "driven by a vano-axial fan with variable - pitch blades; or". The second paragraph was deleted.
	503.4.2.1	Static Pressure Sensor Location	New	This paragraph provides design requirements for static pressure sensors for control of VAV fans.
	503.4.2.2	Set Points for Direct Digital Control	New	This paragraph relocates the second paragraph from Section 503.4.2.
	Table 503.2.3(1)	Unitary Air Conditions and Condensing Units, Electrically Operated, Minimum Efficiency Requirements	Revised	The table was renamed "Minimum Efficiency Requirements: Electrically Operated Unitary Air Conditioners and Condensing Units." The table also includes a column for "Heating Section Type" for equipment. The table also changes the efficiency values of the equipment listed.

A.2 – IECC Code Comparison from the 2009 to the Proposed 2012 Edition

Section	Paragraph Title	Heading	Revision Type	Comment
	Table 503.2.3(2)	Unitary Air Conditioners and Condensing Units, Electrically Operated, Minimum Efficiency Requirements.	Revised	The table was renamed "Minimum Efficiency Requirements: Electrically Operated Unitary and Applied Heat Pumps." The table also includes a column for "Heating Section Type" for equipment. The table also changes the efficiency values of the equipment listed.
	Table 503.2.3(3)	Package Thermal Air Conditioners and Packaged Thermal Heat Pumps	Revised	The table was renamed "Minimum Efficiency Requirements: Electrically Operated Packaged Thermal Air Conditioners, Packaged Thermal Heat Pumps, Single Packaged Vertical Heat Pumps, Room Air Conditioners and Room Air-Conditioner Heat Pumps." The table expands the list of design requirements for cooling equipment. The table also changes the efficiency values for the equipment listed.
	Table 503.2.3(4)	Warm Air Furnaces and Combination Warm Air Furnaces/Air-Conditioning Units Warm Air Duct Furnaces, and Unit Heaters, Minimum Efficiency Requirements	Revised	The table was renamed "Minimum Efficiency Requirements: Warm Air Furnaces and Combination Warm Air Furnaces/Air-Conditioning Units, Warm Air and Duct Furnaces and Unit Heaters."
	Table 503.2.3(5)	Boilers, Gas and Oil-Fired, Minimum Efficiency Requirements	Revised	The table was renamed "Minimum Efficiency Requirements: Gas-and-Oil-Fired Boilers." The table changes the equipment type and subcategory or rating condition. The table also changed the efficiency requirements for the equipment listed.
	Table 503.2.3(6)	Conditioning Units Electrically Operated, Minimum Efficiency Requirements	Revised	The table was renamed "Minimum Efficiency Requirements: Condensing Units, Electrically Operated."
	Table 503.2.3(7)	Water Chilling Packages, Efficiency Requirements	Revised	The table was renamed "Minimum Efficiency Requirements: Water Chilling Packages."
	Table 503.2.8	Minimum Pipe Insulation	Revised	The table was renamed "Minimum Pipe Insulation Thickness." The table was revised to fluid temperatures, insulation conductivity and mean temperature. The table was also revised to expand pipe size.
	503.2.9	HVAC System Completion	Deleted	

A.2 – IECC Code Comparison from the 2009 to the Proposed 2012 Edition

Section	Paragraph Title	Heading	Revision Type	Comment
	503.2.9.1	Air System Balancing	Deleted	
	503.2.9.2	Hydronic Systems Balancing	Deleted	
	503.2.9.3	Manuals	Deleted	
	Table 503.2.10.1(2)	Fan Power Limitation Pressure Drop Adjustment	Revised	The table adds devices and changes the adjustment value for fully ducted return and/or exhaust air system.
	Table 503.3.1(1)	Economizer Requirements	Revised	The table adds climate zones 7 and 8. The table revises the economizer requirements for climate zones 2 and above.
Section 504	504.5	Pipe Insulation	Revised	The revision adds an exception for heat traced piping and untraced piping within a heat traced system.
	504.6	Hot Water System Controls	Revised	The revision requires all circulating hot water and heat traced systems to have the ability to turn them off either automatically or manually. Ready access needs to controls shall be provided.
	504.7	Pools	Revised	The revision expands the requirements to permanently installed spas.
	504.7.2	Time Switches	Revised	The revision extends the requirement to other control methods. The revision also allows for heaters, pumps and motors to have built-in timers.
	504.7.3	Louvers	Revised	The revision adds in ground permanently installed spas. It also deletes the requirement for insulated covers for pools heated above 90 degrees F. The value for pools heated with site-recovered or solar energy in the exception changed from 60 percent to 70 percent.
Section 505	505	General	Revised	The revision adds electrical energy consumption. The exception was revised to allow a choice of complying with Section 505.2 through 505.5 or provide with high efficacy lamps for 75 percent of the permanently installed light fixtures other than low voltage lighting.
	505.2.1	Manual Lighting Controls	Relocated	This section is now Section 502.2.1.1
	505.2.1	Manual Lighting Controls	New	This paragraph requires manual lighting controls to comply with Sections 505.2.1.1 and 505.2.1.2.

A.2 – IECC Code Comparison from the 2009 to the Proposed 2012 Edition

Section	Paragraph Title	Heading	Revision Type	Comment
	505.2.1.2	Lighting Reduction Controls	Relocated/Revised	This section was formerly Section 502.2.2.1. Exception #1 was revised to exempt areas with one luminarie rated less than 100 watts. Exception #2 was revised to include equipment rooms and electrical and mechanical rooms. Exception #6 allows exemption for daylight spaces complying with Section 505.2.2.3.2.
	505.2.2	Additional Lighting Controls	Revised	The revision adds a requirement to comply with Section 505.2.2.3.
	505.2.2	Additional Lighting Controls Exceptions	New	The exceptions create exemptions for sleeping units, spaces with patient care, spaces with occupant safety and security concerns, and lighting for continuous operation.
	505.2.2.1	Lighting Reductions Control	Relocated	This Section is now Section 502.1.2.
	505.2.2.1	Occupant Override	Deleted	
	505.2.2.1	Automatic Time Switch Control Devices	New	This paragraph requires automatic time switch controls for lighting in all areas of the building except for emergency egress or if they are controlled by occupancy sensors. The second paragraph requires that automatic time switch devices have an override that meets the following: readily accessible location, located so the controlled lights are visible, allows manual operation, will allow the controlled lighting to remain on for a maximum of 2 hours, and be limited to control of lighting within a maximum area of 5,000 square feet. The second paragraph exceptions apply to malls, arcades, auditoriums, single tenant retail spaces and industrial facilities. The exception allows extending the time the lights remain on for longer than 2 hours if the switch is a captive key device and extends the square footage allowance from 5,000 square feet to 20,000 square feet.
	505.2.2.2	Automatic Lighting Shut-Off	Deleted	

A.2 – IECC Code Comparison from the 2009 to the Proposed 2012 Edition

Section	Paragraph Title	Heading	Revision Type	Comment
	505.2.2.2	Occupancy Sensors	New	This paragraph requires occupancy sensors to be placed in certain spaces. The sensor will have a 30 minute time limit to turn lights off. The controls shall also have the capability to allow lights to be either automatically or manually turn on to a minimum of 50% power. The exception allows full automatic-on controls in public corridors where manual controls have a safety or security concern.
	505.2.2.2.1	Occupant Override	Deleted	
	505.2.2.2.2	Holiday Schedule	Deleted	
	502.2.3.1	Manual Daylighting Controls	New	This paragraph allows manual controls to be installed in daylight zones.
	502.2.2.3.2	Automatic Daylight Controls	New	This paragraph provides the design requirements for automatic daylighting controls. The controls shall automatically reduce lighting power in response to available day light. They can either be continuous dimming, various dimming ballast or stepped dimming using multi-level switches. See Section - A.4 for daylight zone narrative.
	505.2.2.3.3	Multi-Level Lighting Controls	New	This paragraph requires a multi-level lighting control for general lighting in daylight zone. See Section - A.4.
	505.2.3	Specific Application Controls	New	This paragraph establishes requirements for specific lighting including display and accent lighting, lighting in cases, hotel and motel sleeping units, supplemental task lighting, lighting for non-visual applications and demonstration lighting.
	505.5.2	Interior Lighting Power	Revised	The revision changes the total interior lighting power calculations based on either the building area method per Table 505.5.2(1) or space by space method per Table 505.5.2(2).
	Table 505.5.2	Interior Lighting Power Allowances	Deleted	
	Table 505.5.2(1)	Interior Lighting Power Allowances: Building Area Method	New	The Table provides watts per foot for building types.
	Table 505.5.2(2)	Interior Lighting Power Allowances: Space-by-Space Method	New	The Table provides watts per foot for building spaces.

A.2 – IECC Code Comparison from the 2009 to the Proposed 2012 Edition

Section	Paragraph Title	Heading	Revision Type	Comment
Section 506	506	Total Building Performance	Deleted	The Section is now 507.
Section 506	506	Additional Efficiency Package Options	New	
	506.1	Requirements	New	This paragraph requires buildings to meet efficient HVAC systems, efficient lighting systems or on-site supply of renewable energy. See Section - B.8 for narrative on Additional energy performance.
	506.2	Efficient HVAC Performance	New	This paragraph will require HVAC equipment to exceed the efficiency specified in Section 503 to the efficiencies per Table 506.2(1) through 506.2(7).
	Table 506.2(1)	Unitary Air Conditioners and Condensing Units Electrically Operated Efficiency Requirements	New	This Table produces the additional efficiency requirements for the air conditioning equipment listed.
	Table 506.2(2)	Unitary and Applied Heat Pumps, Electrically Operated Efficiency Requirements	New	This Table provides the additional efficiency requirements for heat pumps.
	Table 506.2(3)	Packaged Thermal Air Conditioners and Package Thermal Heat Pumps	New	This Table provides the additional efficiency requirement for thermal units.
	Table 506.2(4)	Warm Air and Combination Warm Air Furnaces/Air-Conditioning Units, Warm Air Duct Furnaces and Unit Heaters, Efficiency Requirements	New	This Table provides the additional efficiency requirements for warm air systems.
	Table 506.2(5)	Boiler Efficiency Requirements	New	This Table provides the additional efficiency requirement for boilers.
	Table 506.2(6)	Chillers - Efficiency Requirements	New	This Table provides the additional efficiency requirements for chillers.
	506.3.1	Reduced Lighting Power Density	New	This paragraph will require the total interior lighting power to exceed the limits specified in Section 505.5.2 as per Table 506.3.
	Table 506.3	Reduced Interior Lighting Power	New	The Table provides the additional watts/foot for building types.
	506.4	On-Site Renewable Energy	New	This paragraph provides the minimum requirements for on-site renewable energy.
Section 507	507	Scope	New	Establishes the criteria for building performance.
	507.2	Mandatory Requirements	New	Requires mandatory compliance with Sections 502.4, 503.2, 504 and 505.
	507.3	Performance Based Compliance	New	Allows building energy compliance based on a performance criteria

A.2 – IECC Code Comparison from the 2009 to the Proposed 2012 Edition

Section	Paragraph Title	Heading	Revision Type	Comment
	507.4	Documentation	New	Establish criteria for documentation to verify performance.
	507.4.1	Compliance Report	New	This paragraph establishes the requirements for a compliance report documenting the reference design and proposed design.
	507.4.2	Additional Documentation	New	This paragraph allows the code official to request additional documentation.
	507.5	Construction Procedure	New	This paragraph note that the method used to calculate the proposed design and the referenced design must be intentional.
	507.5.1	Building Specifications	New	This paragraph references Tables 507.5.1(1), 502.2 for configuring the proposed design and reference design.
	507.5.2	Thermal Blocks	New	Thermal blocks shall be analyzed using paragraphs 507.5.2.1, 507.5.2.2, or 507.5.2.3.
	507.5.2.1	HVAC Zone Design	New	This paragraph states that HVAC zones will be modeled as separate thermal block with exceptions.
	507.5.2.1	HVAC Zone Design, Exceptions	New	This paragraph allows for exceptions in modeling HVAC zones.
	507.5.2.2	HVAC Zones Not Designed	New	This paragraph provides criteria for HVAC zones not designed. The criteria includes internal lead densities, occupancy, lighting, thermal and temperature scheduled.
	507.5.2.3	Multifamily Residential Buildings	New	This paragraph requires residential space to be modeled using one thermal block.
	507.6	Calculation Software Tools	New	This paragraph provided criteria for software tools used to calculate the proposed design and the referenced design.
	507.6.1	Specific Approval	New	This paragraph requires the performance analysis to comply with Section 507, ASHRAE standard 140 and as approved by the code official.
	507.6.2	Input Valves	New	This paragraph states that input valves not referenced in the code shall come from an approved source.
	Table 507.5.1(1)	Specifications for the Standard Reference and Proposed Design	New	This Table provides input specifications for building components.
	Table 507.5.1(2)	HVAC Systems Map	New	This Table provides the standard preference design for HVAC equipment.
	Table 507.5.1(3)	Specifications for the Standard Reference Design HVAC System Descriptions	New	This Table identifies the system types as referenced by Table 507.5.1(2).
	Table 507.5.1(4)	Number of Chillers	New	This Table identifies the number of chillers to be defined in the referenced design based on tons.

A.2 – IECC Code Comparison from the 2009 to the Proposed 2012 Edition

Section	Paragraph Title	Heading	Revision Type	Comment
	Table 507.5.1(5)	Water Chiller Types	New	This Table identifies chiller types to be defined in the referenced design based on tons and power type.
Section 508		System Commissioning	New	
	508.1	General	New	This paragraph requires building mechanical systems, electrical power and lighting systems to be commissioned.
	508.2	Mechanical Systems Commissioning and Completion Requirements	New	This paragraph requires the design professional to provide evidence of mechanical system commissioning. The construction documents shall provide provisions for commissioning and completion. Buildings with less than 480,000 Btu/h cooling capacity and 600,000 Btu/h heating capacity and systems that serve dwelling units and sleeping units. See Section - A.6 for building commissioning narrative.
	508.2.1	Commissioning Plan	New	This paragraph requires the design professional or approved agency to develop a commissioning plan. The plan shall include narrative of activities to be completed in the commissioning phase, list of equipment to be commissioned, equipment functions to be tested, conditions of test and the measurement criteria for performance.
	508.2.2	Systems Adjusting and Balancing	New	This paragraph requires HVAC systems to be balanced, air and water flow rates shall be measured and adjusted to meet tolerances testing and balancing shall also meet Sections 508.2.2.1 and 508.2.2.2.
	508.2.2.1	Air System Balancing	New	This paragraph requires air supply outlets and thermal devices shall be equipped with a means of air balancing. It prohibits dumping on constant and variable volume fans with motors 10 horsepower or larger. It also provides requirements for air system balancing. The paragraph also provides an exception for fan motors 1 horsepower or less.
	508.2.3	Function Performance Testing	New	This paragraph requires testing to comply with Sections 508.2.3.1 through 508.2.3.3.

A.2 – IECC Code Comparison from the 2009 to the Proposed 2012 Edition

Section	Paragraph Title	Heading	Revision Type	Comment
	508.2.3.1	Equipment	New	This paragraph requires functional performance test to demonstrate the installation operation, and interface relationship to verify compliance with plans and specifications and confirm operation and service ability. The testing shall include operation in all modes and sequence of operation. The paragraph provides an exception for unitary or packaged HVAC equipment listed in Tables 503.2.3(1) through 503.2.3(3) that do not require supply air economizers.
	508.2.3.2	Controls	New	This paragraph requires testing and adjusting of HVAC controls to comply with plans and specifications.
	508.2.3.3	Economizers	New	This paragraph requires all economizers to be functionally tested.
	508.2.4	Preliminary Commissioning Report	New	This paragraph requires that the design professional or agency shall prepare a preliminary report for the owner. The report shall include itemization of deficiencies from testing, differed test and climate conditions required for deferred test.
	508.2.4.1	Acceptance of Report	New	This paragraph requires the building official to receive a notification that the building owner has received the preliminary commissioning report prior to final mechanical
	508.2.4.2	Copy of Report	New	This paragraph permits the building official to request a copy of the preliminary commissioning report.
	508.2.5	Documentation Requirements	New	This paragraph requires the construction documentation to specify that the documents noted in Sections 508.2.5.1 and 508.2.5.2 to be provided to the owner within 90 days of the certificate of occupancy.
	508.5.1	Drawings	New	The construction documents shall include the location and performance data on each piece of equipment.
	508.5.2	Manuals	New	This paragraph requires the operation and maintenance manuals to include the following: equipment submittal data, manufacturer's operation and maintenance data, name of servicing agent, HVAC control system maintenance and calibration information and a narrative of how each system is intended to operate, include set points.

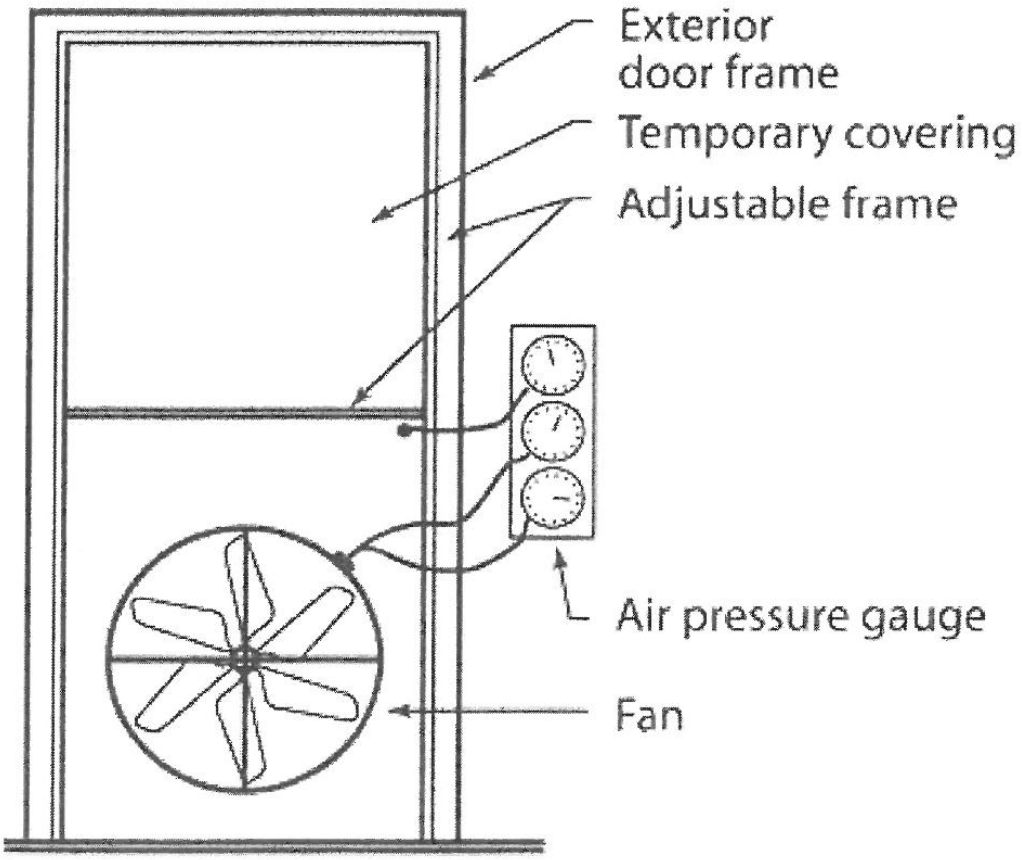
A.2 – IECC Code Comparison from the 2009 to the Proposed 2012 Edition

Section	Paragraph Title	Heading	Revision Type	Comment
	508.5.3	System Balancing Report	New	This paragraph requires a written report describing the activities and measurements per Section 508.2.2.
	508.2.5.4	Final Commissioning Report	New	This paragraph requires a final commissioning report to be issued to the owner. The report shall include: results of functional performance test, disposition of deficiencies with details of corrective measures and function performance test procedures and measurable criteria for test. The paragraph allows for an exception of test deferred due to climate conditions.
	508.3	Lighting Systems Functional Testing	New	This paragraph requires functional testing for lighting systems per Section 508.3.1.
	508.3.1	Functions Testing	New	This paragraph requires testing of the hardware and software for lighting systems are calibrated, adjusted, programmed, and in good working order. The construction documents shall identify the party to do the testing. The code official may require a third party to do the testing. The testing shall include confirmation of placement, sensitivity and time-out of occupant sensors, confirm time switches and programmable controls, turn lights off and confirm that the placement and sensitivity of photo sensor controls reduce electric light based on usable daylight.

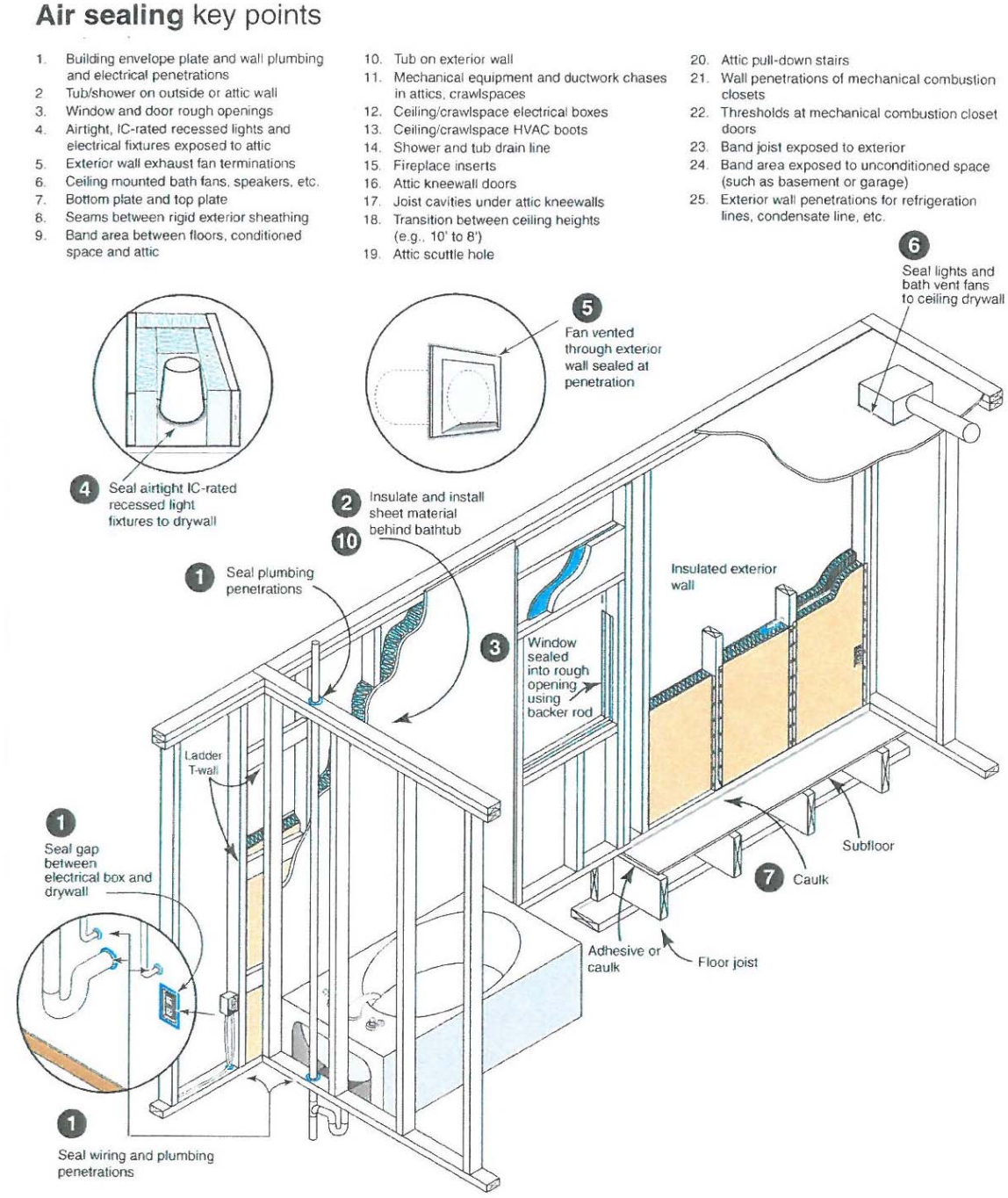
Chapter 6 - References (No Data Available)

Diagnostic Tools

Testing the airtightness of a home using a special fan called a blower door can help to ensure that air sealing work is effective. Often, energy efficiency incentive programs, such as the DOE/ EPA ENERGY STAR Program, require a blower door test (usually performed in less than an hour) to confirm the tightness of the house.



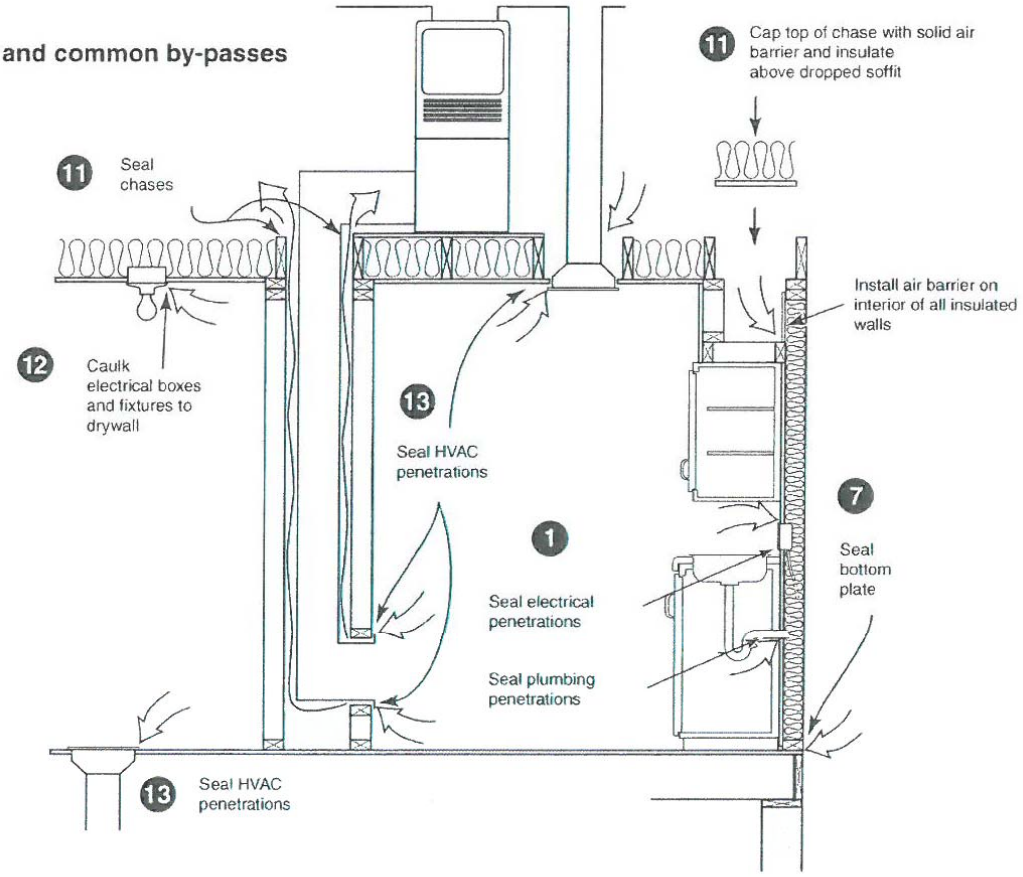
A.3.1 Blower Door Test Equipment



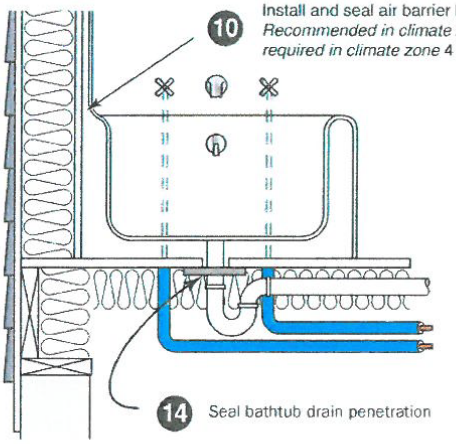
A.3.2 Envelope Sealing Details

Air sealing key points *continued*

Chases and common by-passes

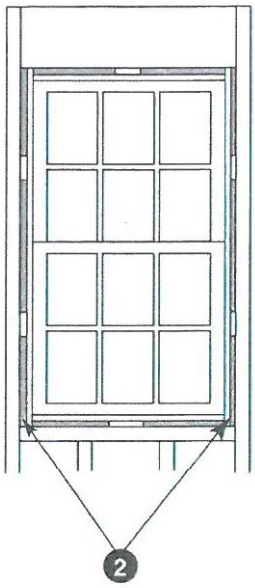


Shower/tub drain rough opening



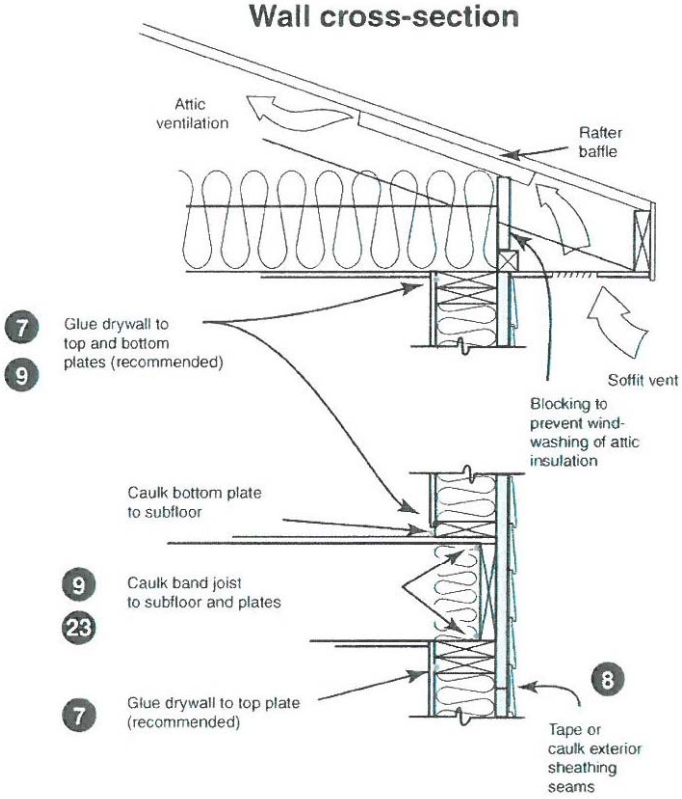
Air sealing key points *continued*

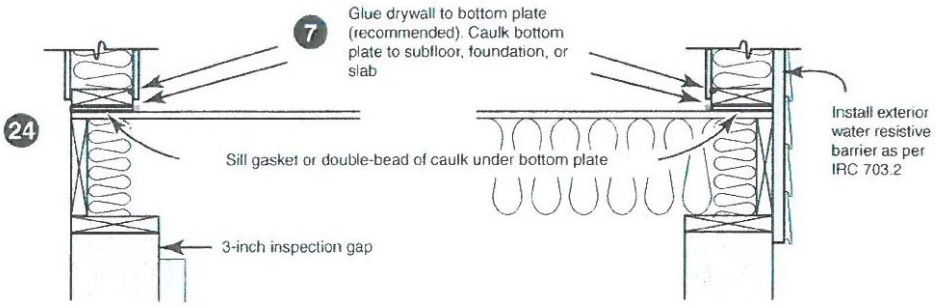
Window rough opening



Use backer rod or spray foam (appropriate for windows) to fill gaps between window/door and rough opening

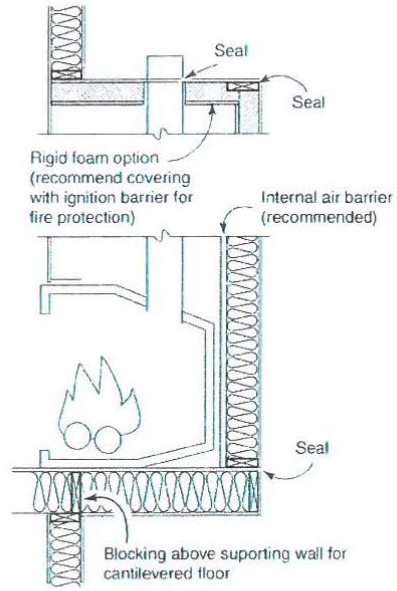
Wall cross-section





Air sealing key points *continued*

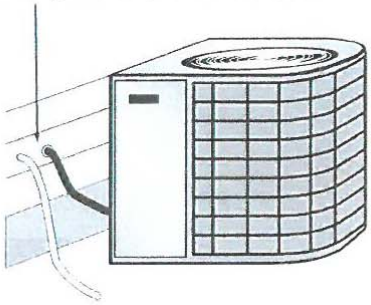
Combustion chase penetrations



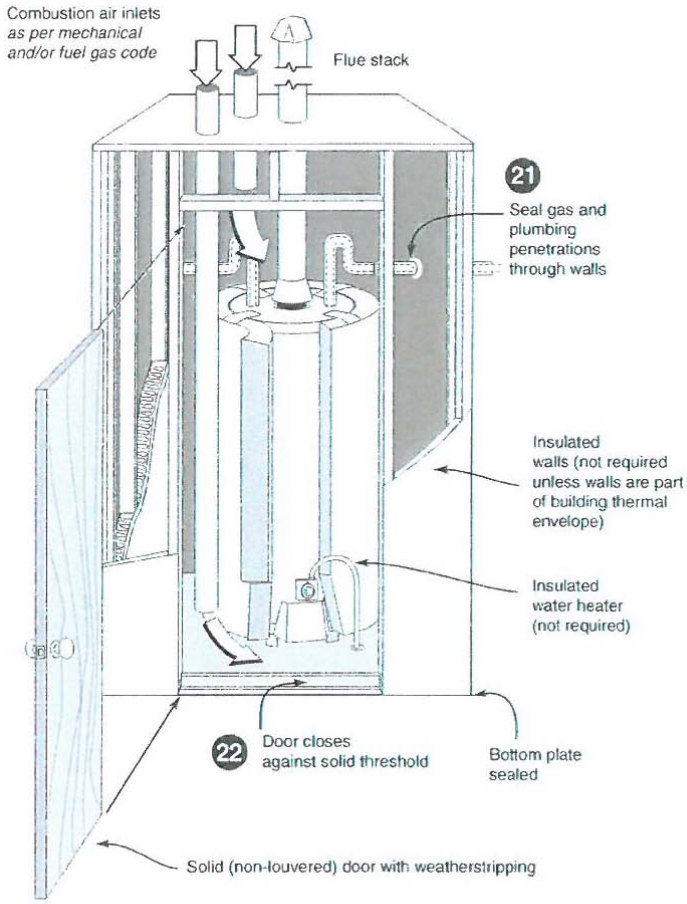
15 Seal around chimney flues with sheet metal cap

Exterior penetrations

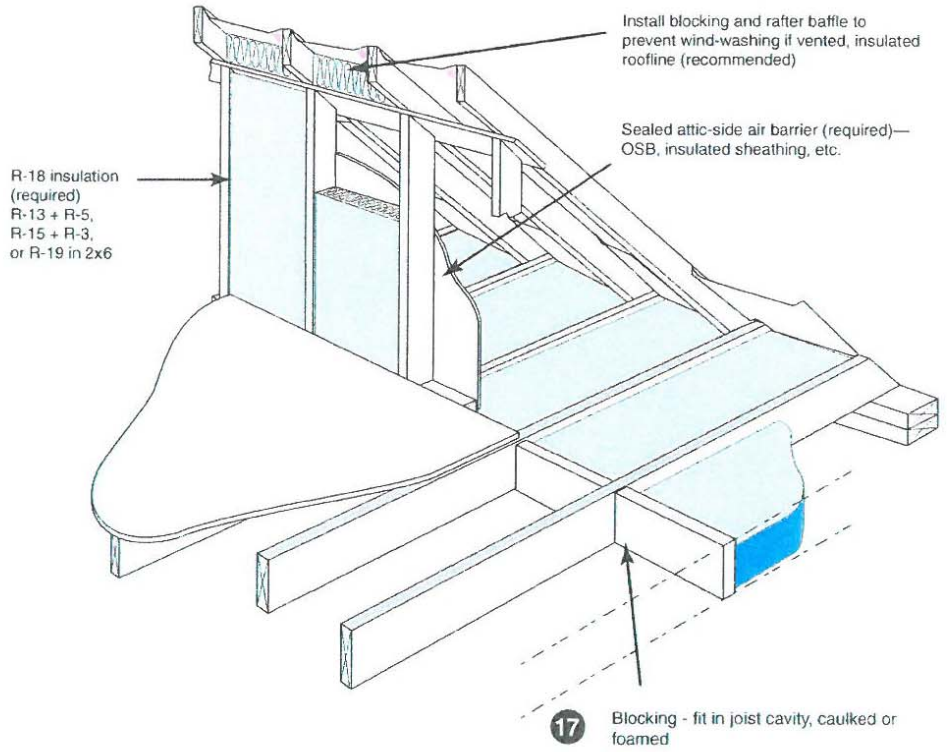
25 Caulk exterior wall penetrations for refrigeration lines, condensate line, etc.



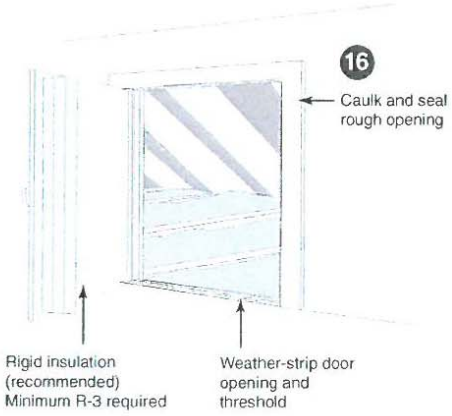
Combustion closet



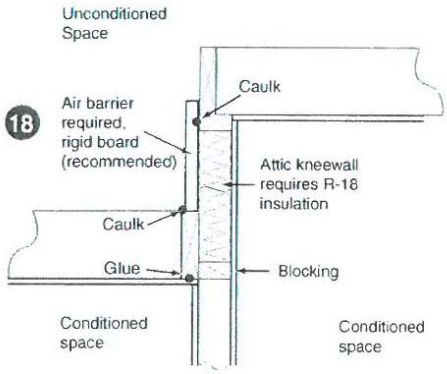
Air sealing key points *continued*



Attic knee-walls

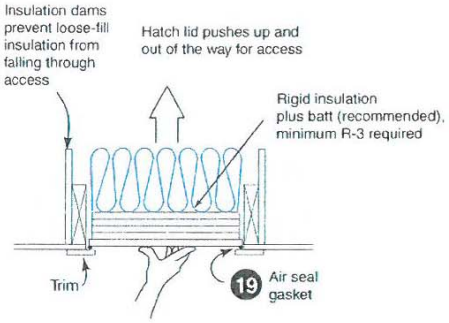


Two-level attic

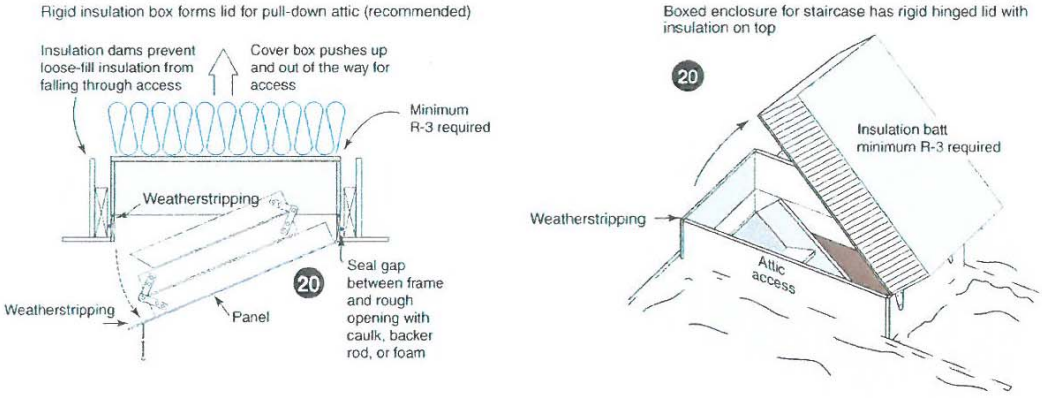


Air sealing key points *continued*

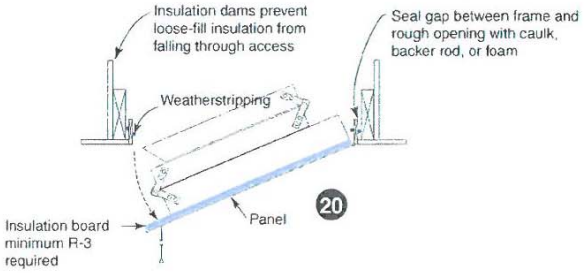
Attic scuttle

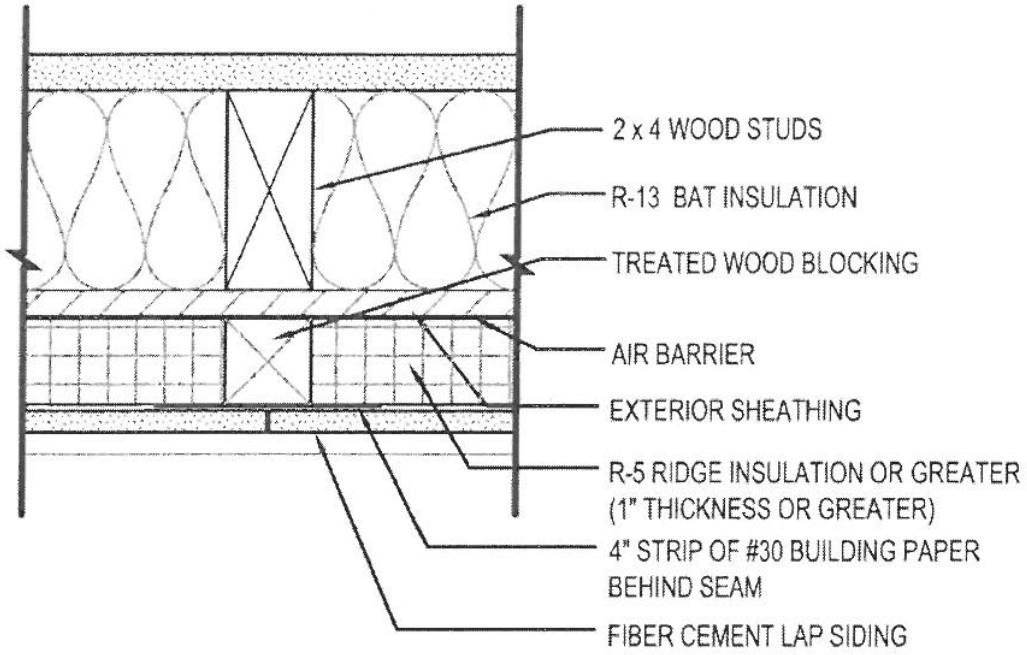


Attic pull-down stairs

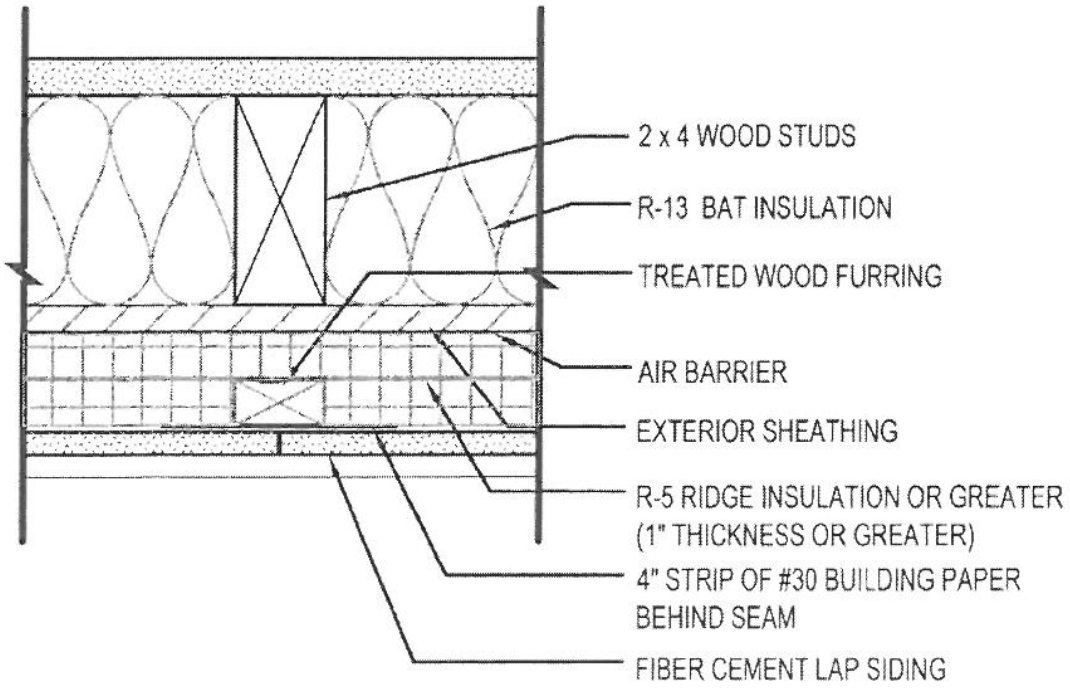


Attic pull-down stairs

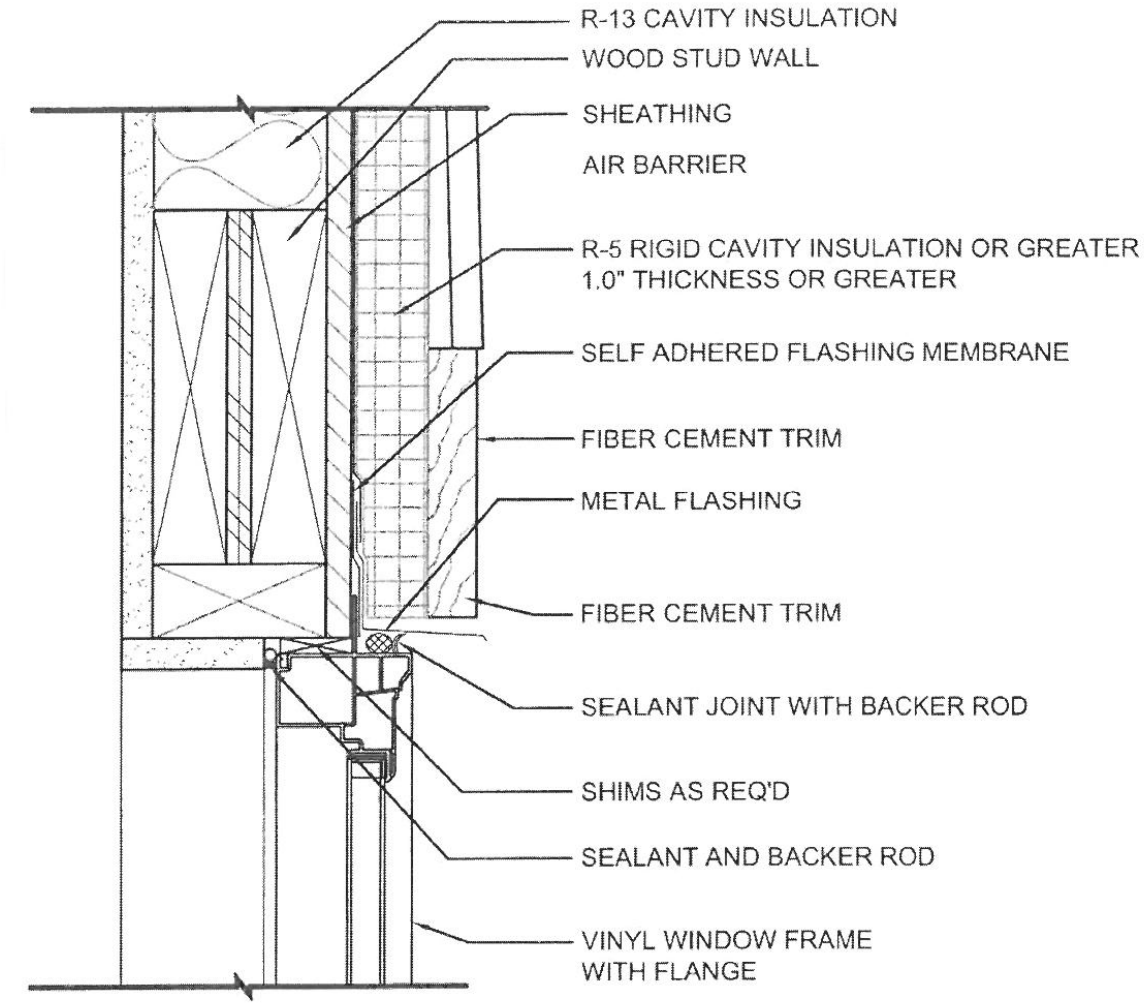




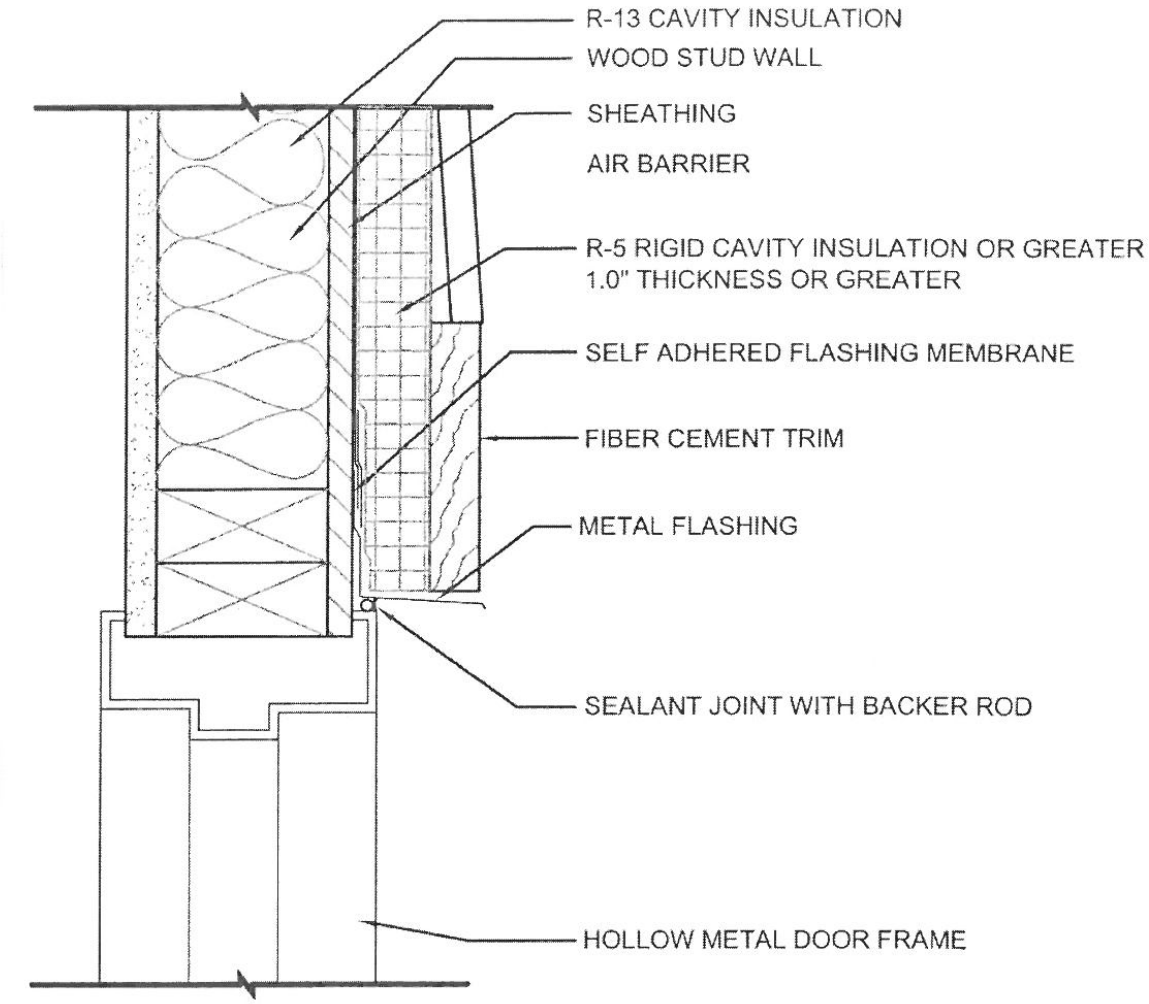
A.3.3 Lap Siding Fastening Detail Option #1



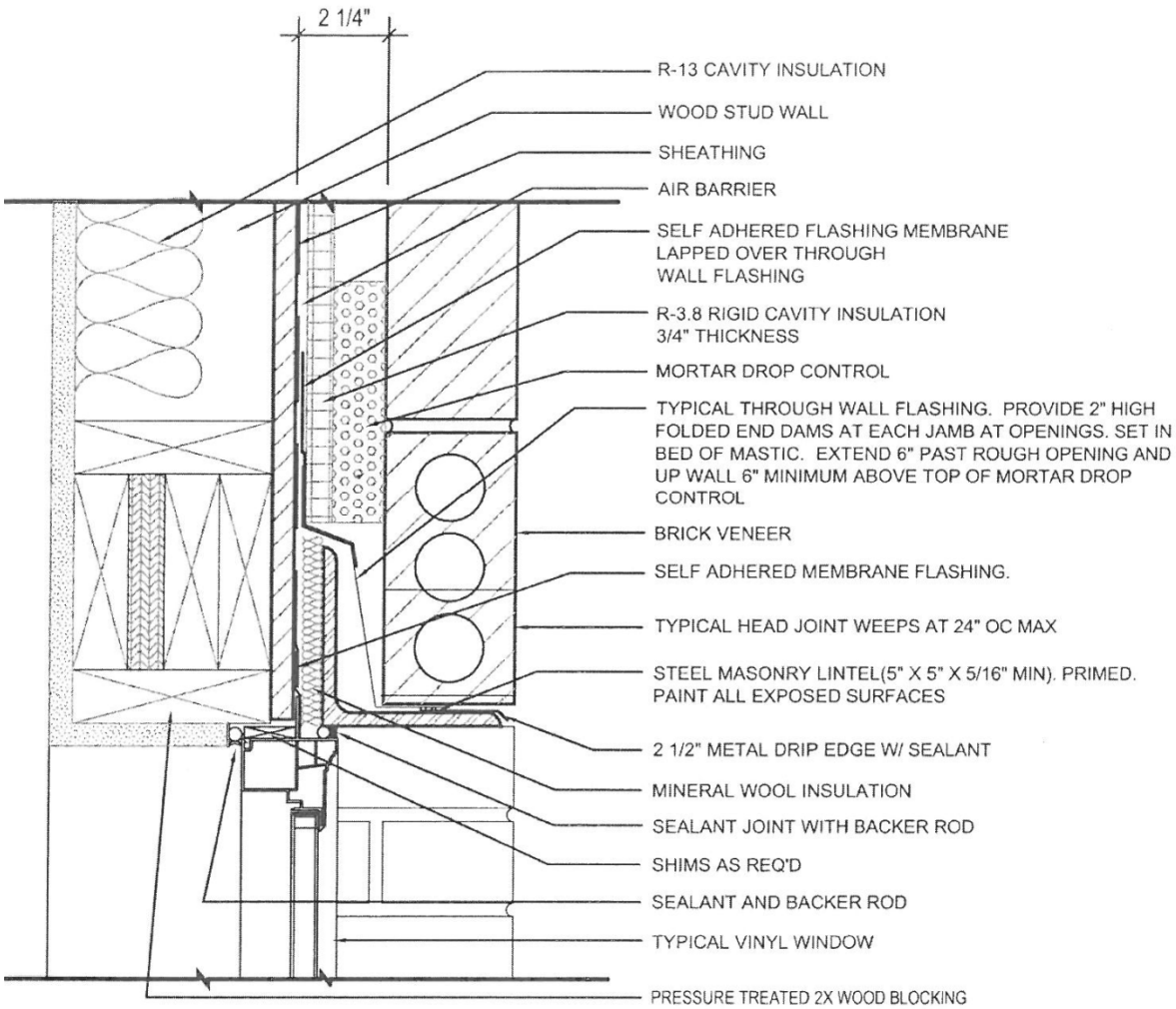
A.3.4 Lap siding Detail Option #2



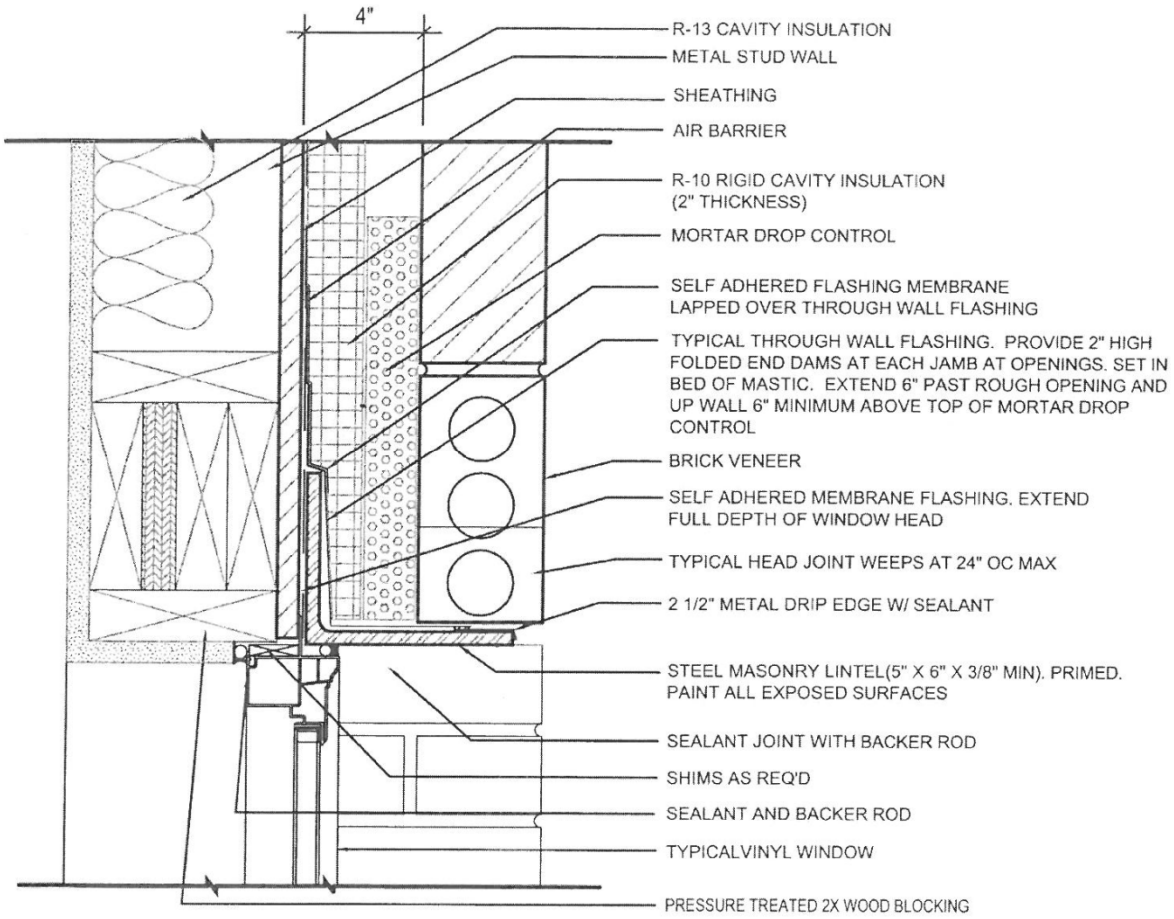
A.3.5 Window Head Detail at Lap Siding



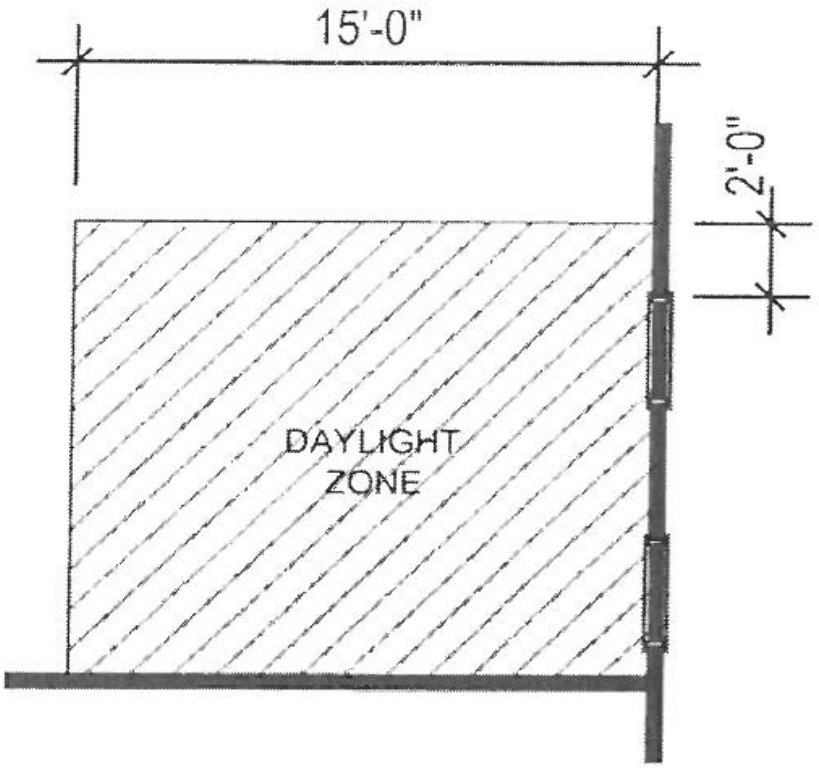
A.3.6 Door Head Details at Lap siding



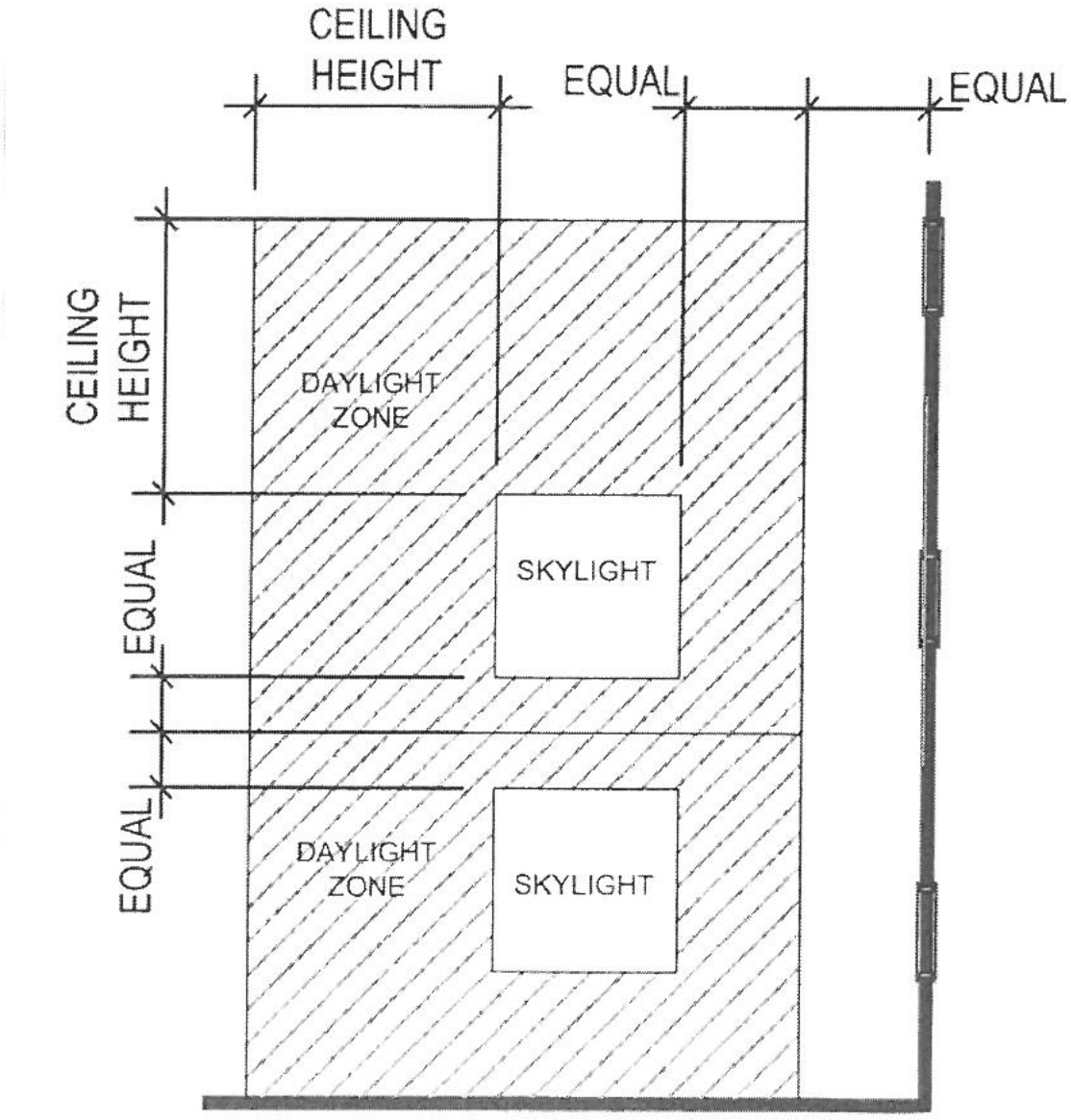
A.3.7 Window Head Detail at Brick with a 2 1/4 inch Cavity



A.3.8 Window Head Detail at Brick with a 4 inch Cavity



A.3.9 Daylight Zone



A.3.10 Daylight Zone Under Skylight