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

Prepared for:

National Multi Housing Council
National Apartment Association

Niles Bolton Associates, Inc.
One Buckhead Plaza
3060 Peachtree Road, NW
Suite 600
Atlanta, Georgia 30305

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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.

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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.

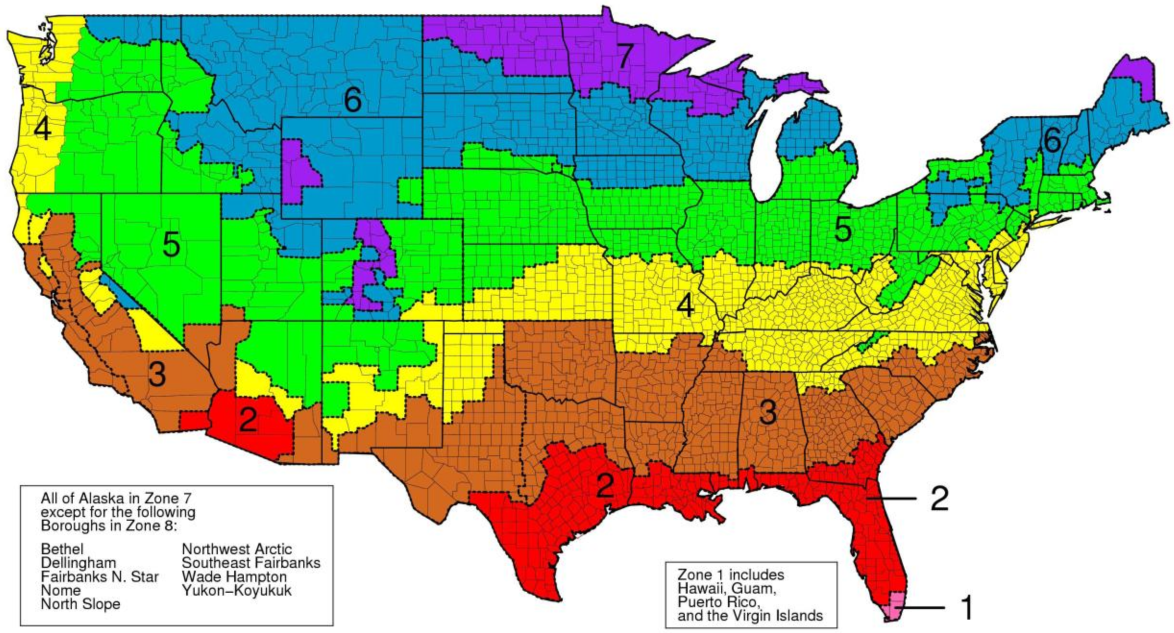
Until recently, the 2006 IECC edition was the most prevalent code in use nationwide, but many jurisdictions are now adopting the 2009 edition. And, even though fewer than 30 states have adopted the 2009 (or equivalent) code to date[3], some states and municipalities are already vetting the 2012 version. 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.

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[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.

<u>LOW-RISE MULTIFAMILY</u>

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

		Lap Siding Veneer	Brick Veneer
•	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.