Multi-Family and Single-Family Homes: A Comparison of Building Code Requirements and Building Science Considerations

RESNET Conference
February 29, 2016

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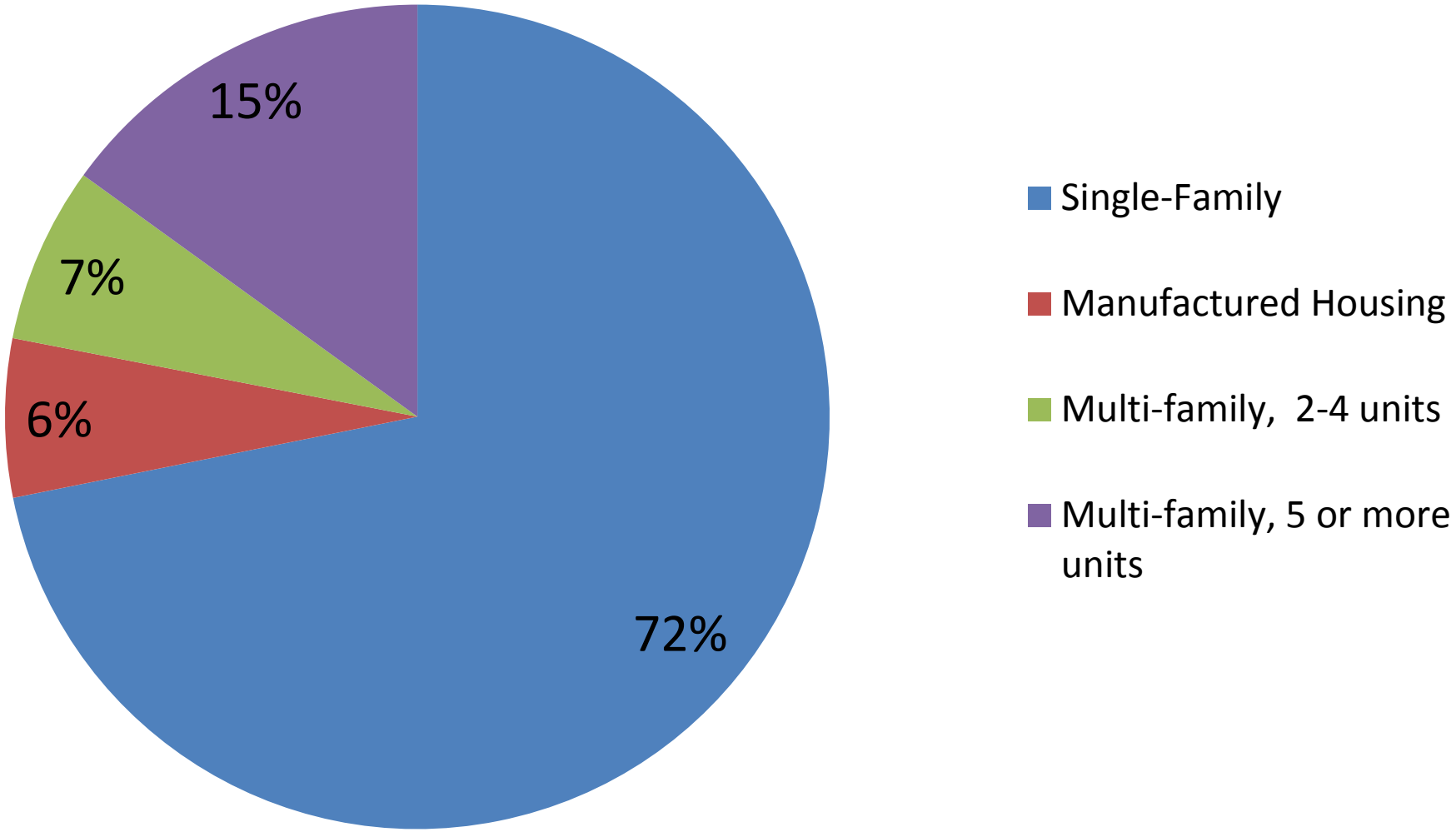
DuPont Protective Solutions

Learning Objectives

- Review how residential market is evolving, especially as it pertains to multi-family construction.
- Understand different building science and construction challenges involved in multi-family construction.
- Understand differences in building and energy code requirements for wood frame single family and multi-family construction

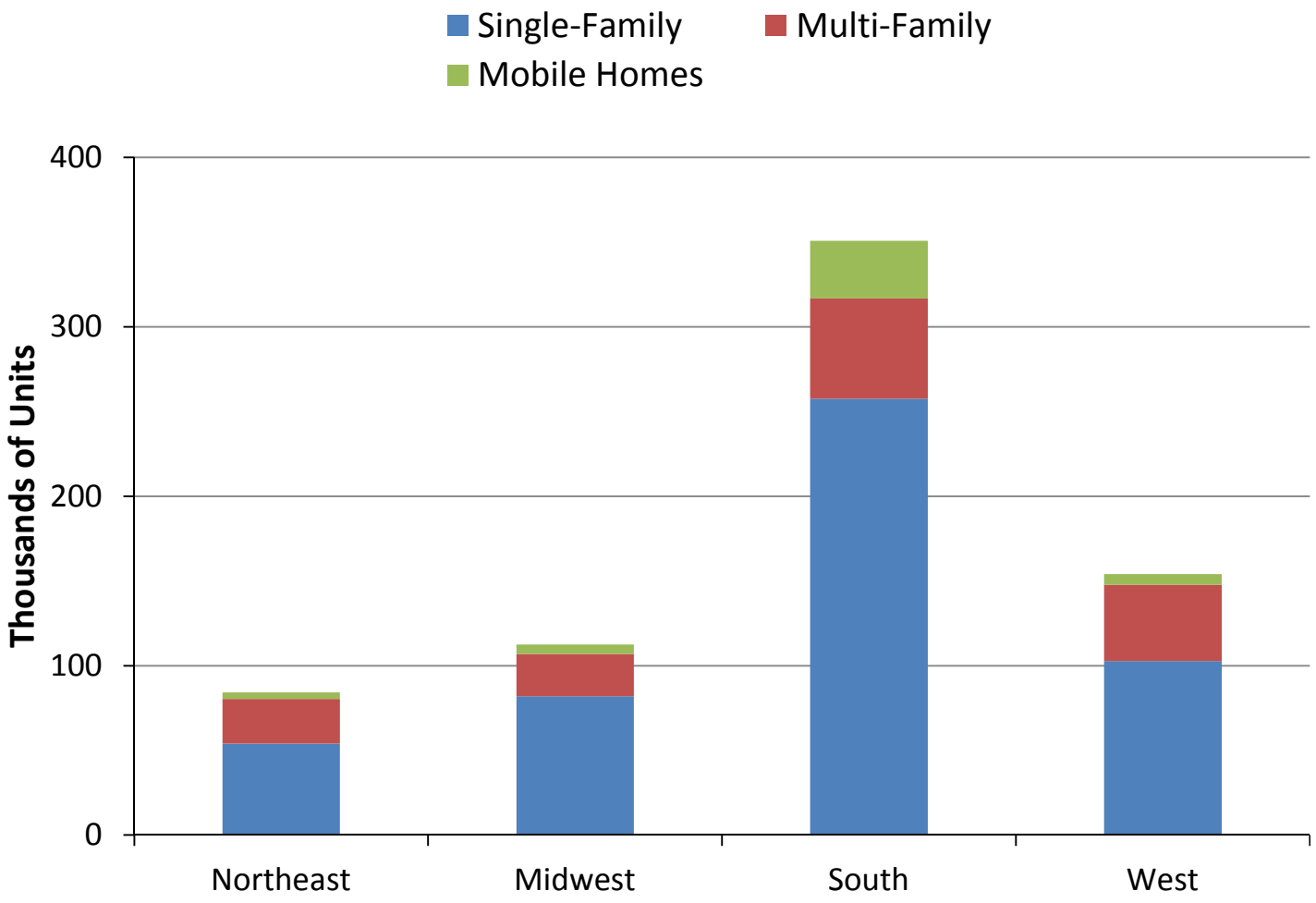
Share of Households



Source: EIA, A Look at Residential Energy Consumption in 2005, July 2008

2010 Completed Unit Regional Distribution:

Northeast: 31%, Midwest: 22%, South: 23%, West: 29%



Bloomberg

Housing Starts in U.S. Rise on Multifamily Properties

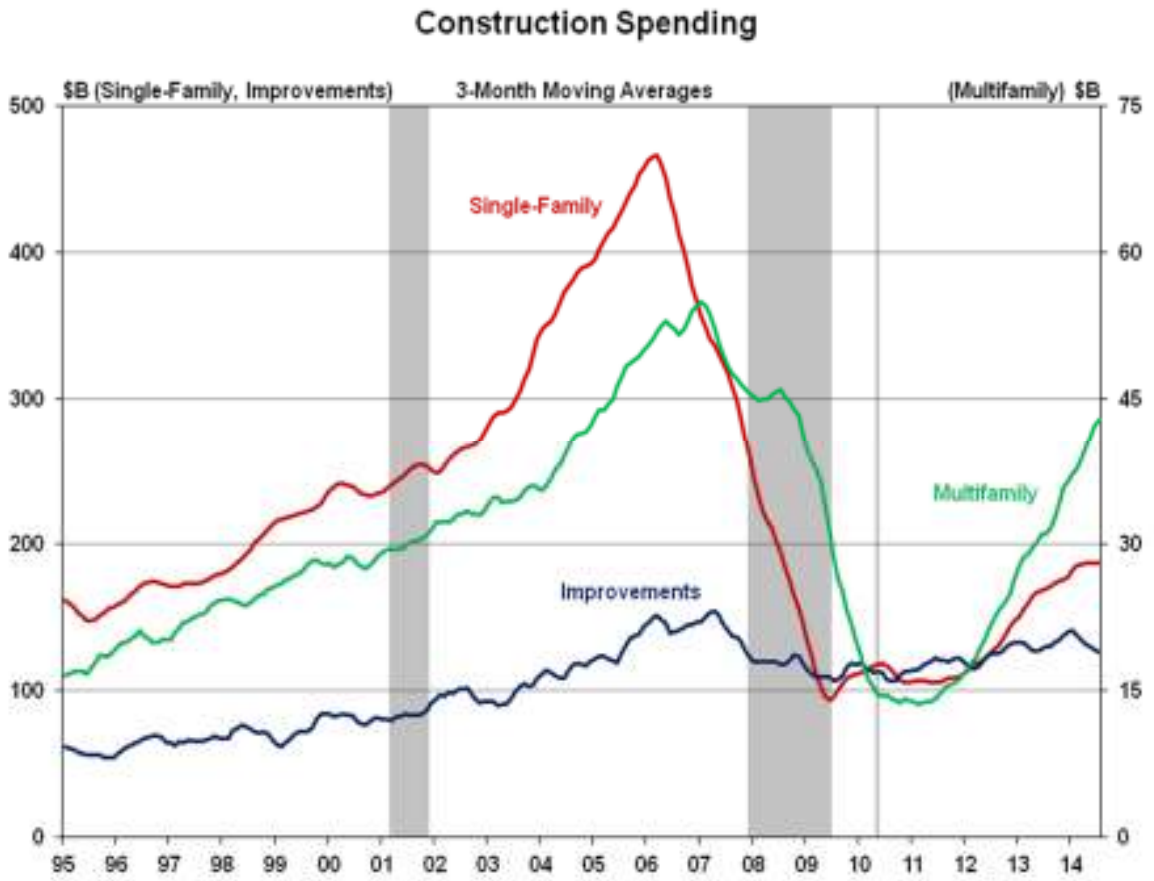
By Victoria Stilwell and Lorraine Woellert - ***Aug 16, 2013***

"Builders started work on fewer single-family homes in July, marking a pause in the residential construction rebound that's helping to propel the U.S. economy. Work began on 2.2 percent fewer individual homes last month, taking them to a 591,000 annualized rate, the least since November, Commerce Department data showed today in Washington. Total housing starts climbed to an 896,000 pace, propelled by a rebound in the multifamily category, which can be volatile.

…

Work on multifamily homes, such as apartment buildings, jumped 26 percent to a 305,000 rate after falling 24.8 percent in June."

September 2014: Construction Spending



On a 3-month moving average basis from July 2013:

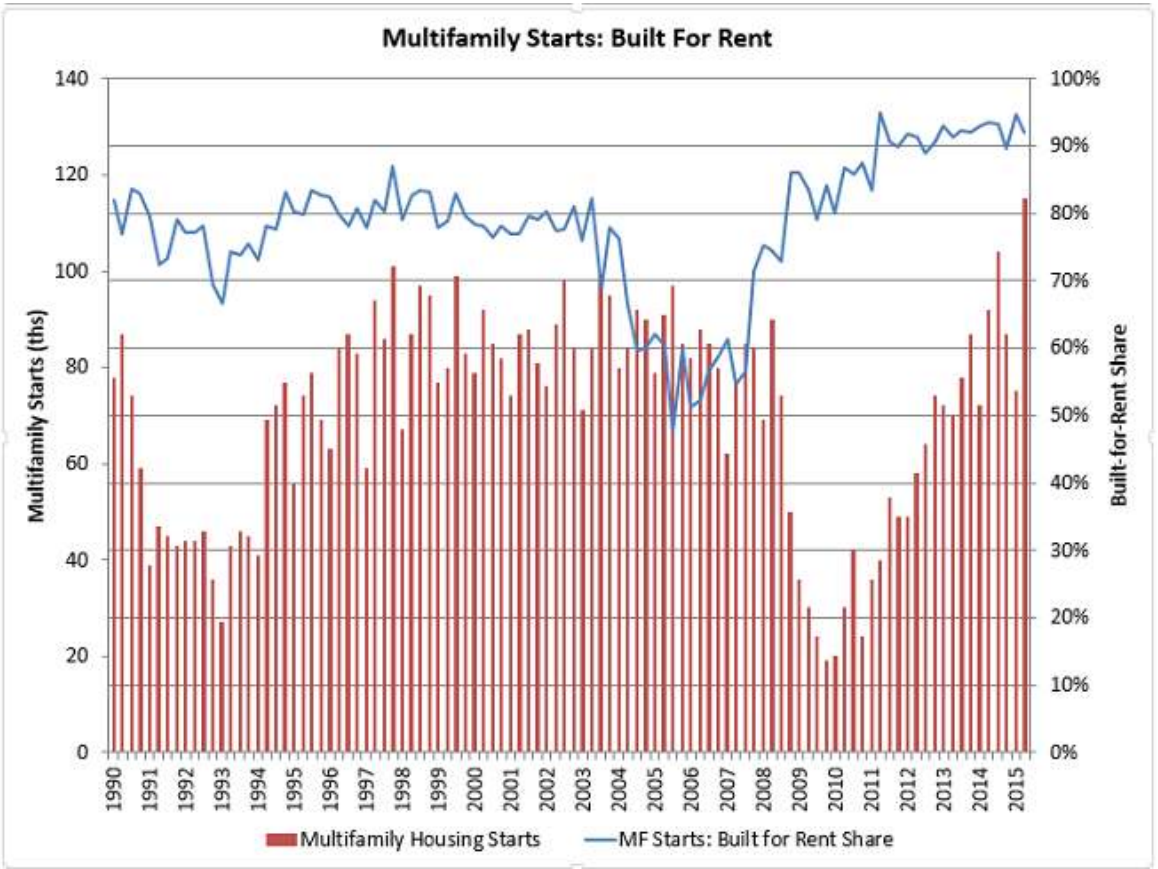
- Single Family increased 9.9 %
- Multi-Family increased 38.4%

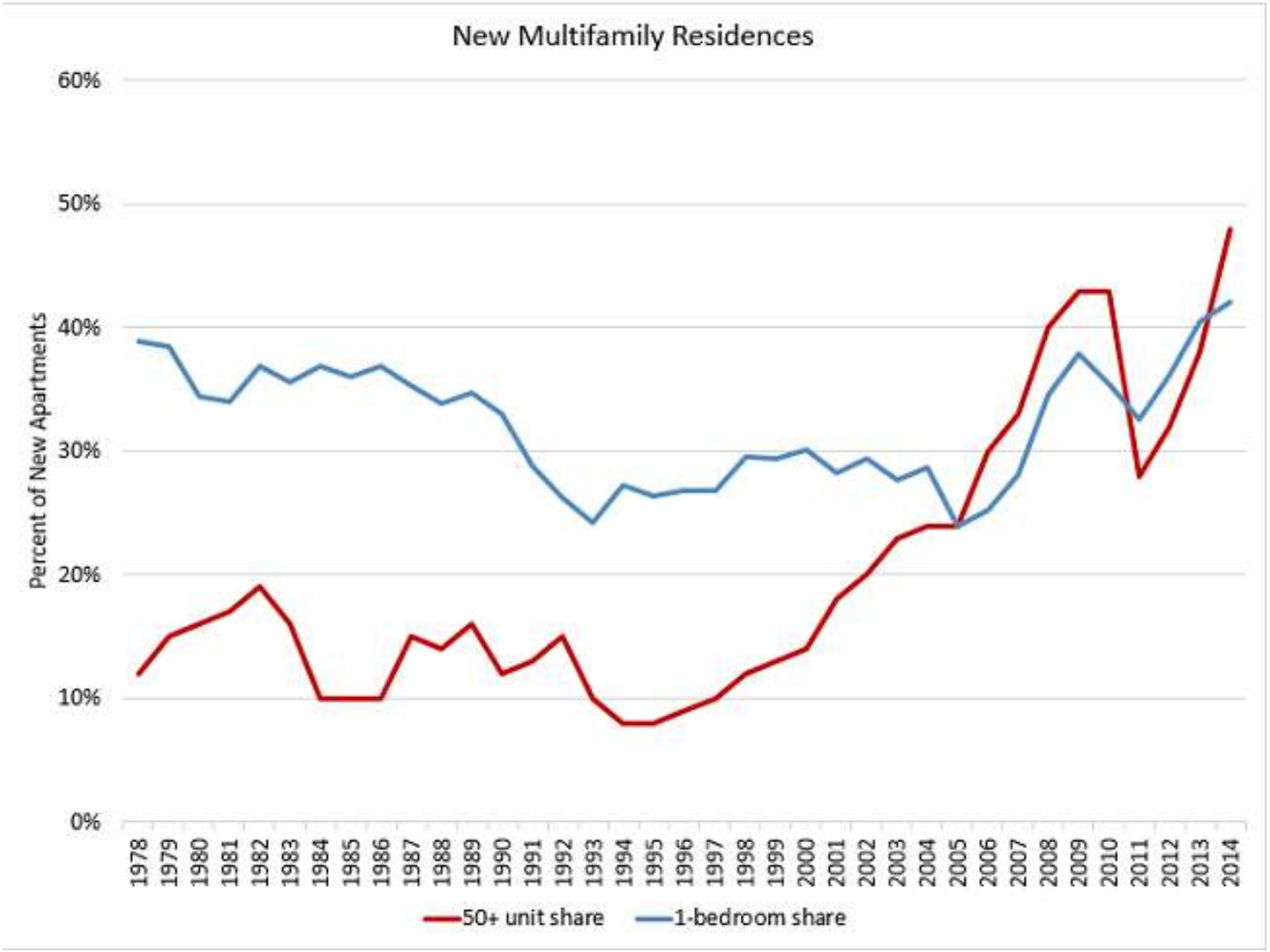
U.S.News & WORLD REPORT

Renters' Paradise? Multifamily housing construction is booming, especially in the rental sector.

By Robert Dietz Oct. 22, 2015

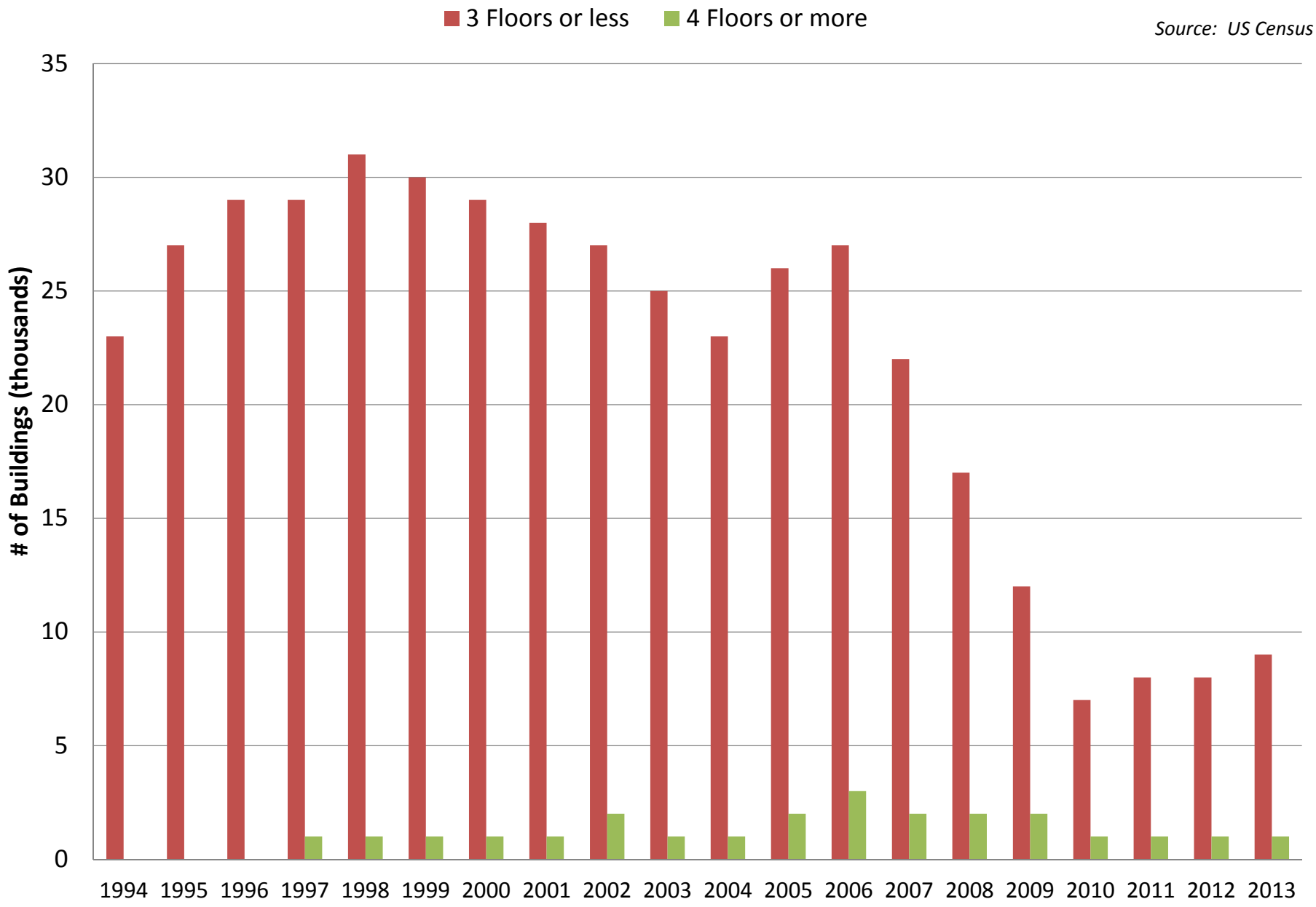
- Single-family home construction growth with rate of more than 20% from 2012 to 2014
- Multifamily building increased 43%
- This growth was propelled by an increase in rental demand, particularly from younger households.



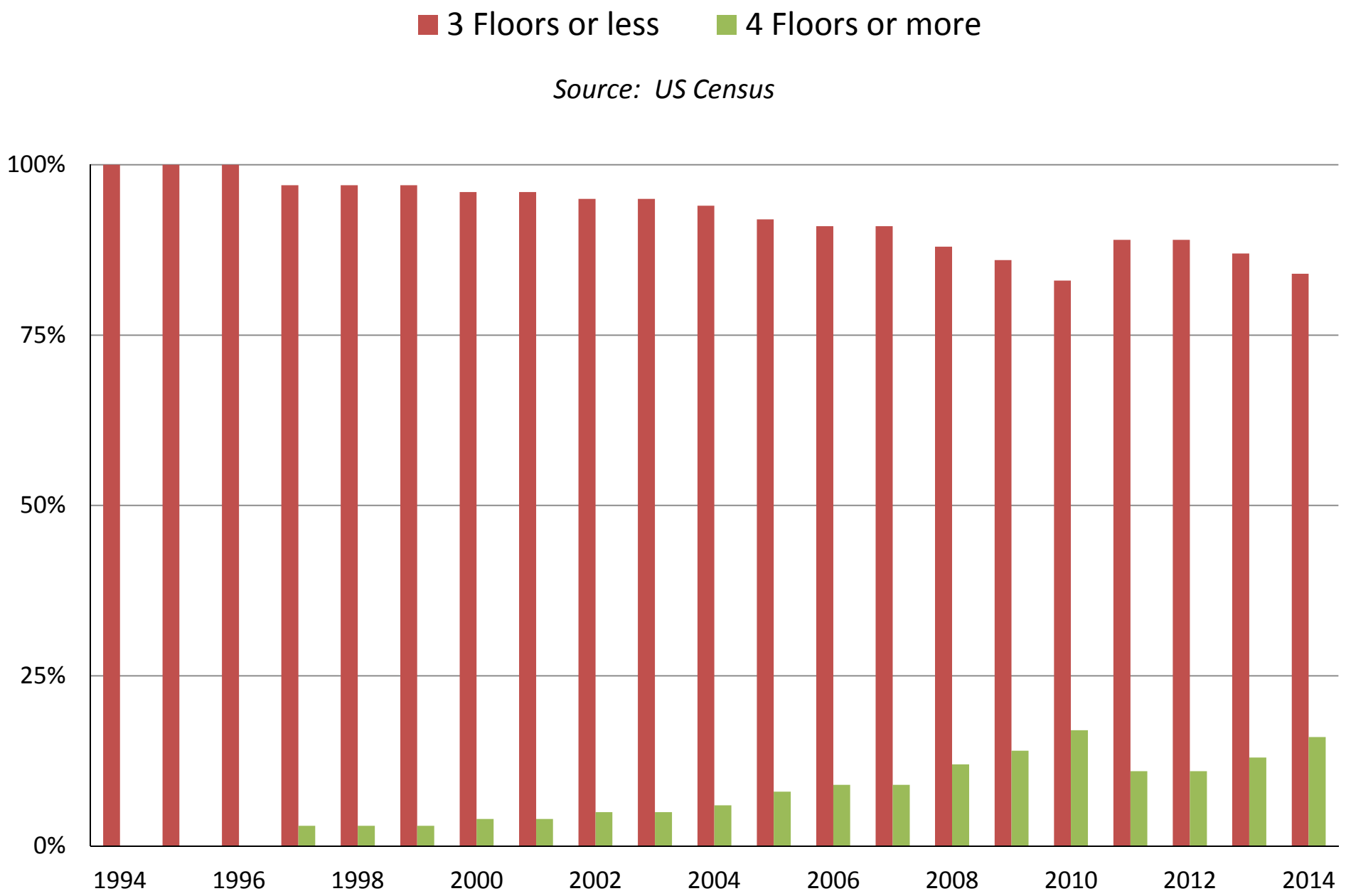


Source: US News & World Report

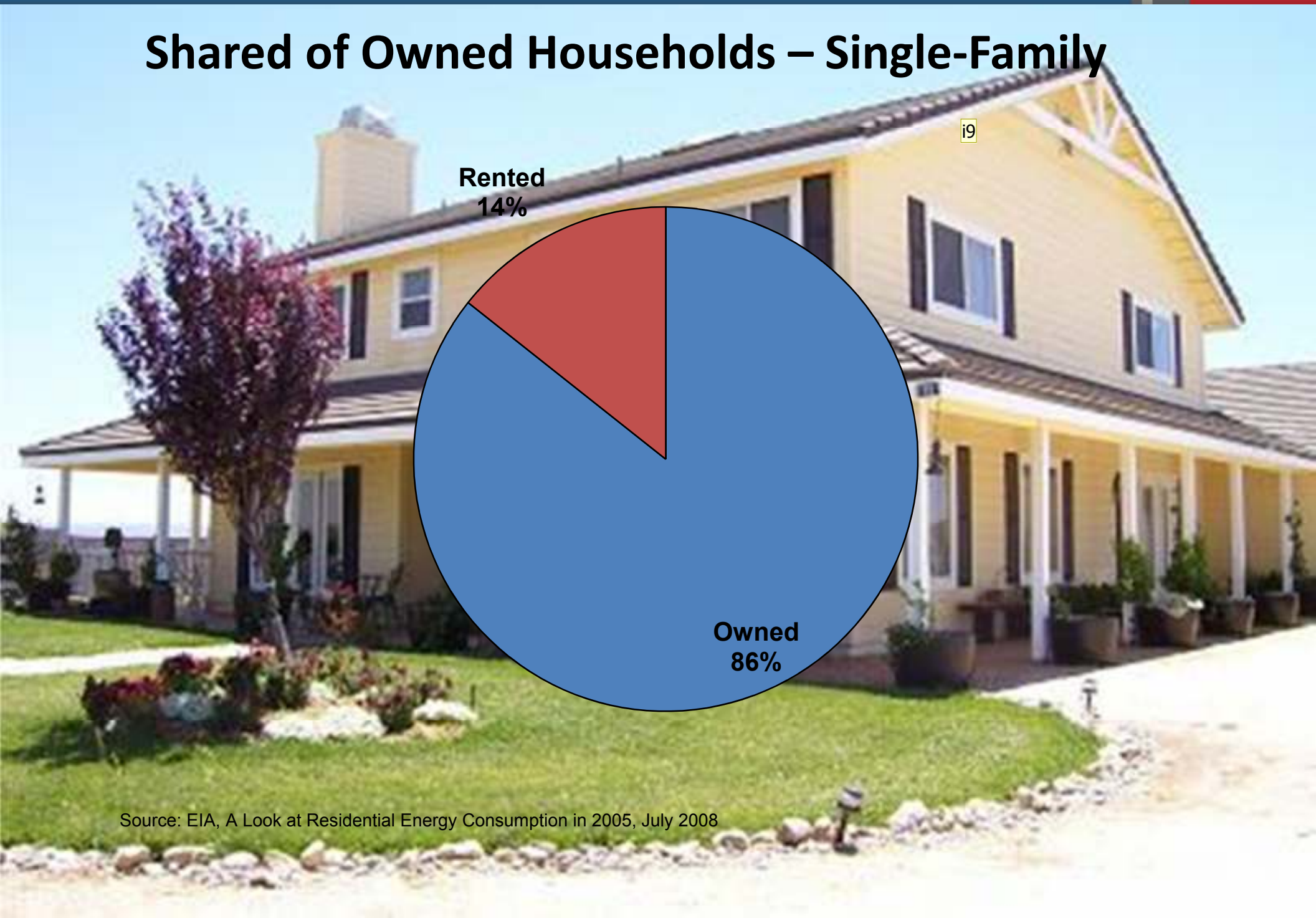
Number of Multifamily Units Completed by Number of Floors in Building



Multifamily Units Completed by Number of Floors in Building



Shared of Owned Households – Single-Family

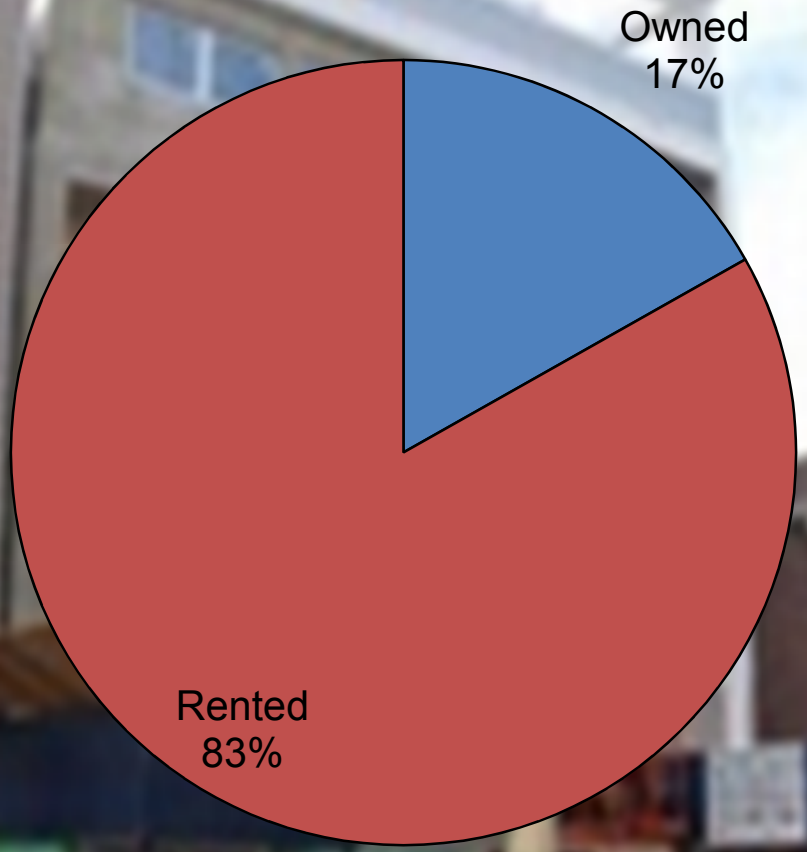


Source: EIA, A Look at Residential Energy Consumption in 2005, July 2008

Slide 11

i9 Update
iPad, 2/20/2016

Shared of Owned Households – Multi-Family



Source: EIA, A Look at Residential Energy Consumption in 2005, July 2008

New Urbanism

Creating Livable Sustainable Communities

- NEW URBANISM
- SUSTAINABILITY
- SPRAWL COSTS
- DENSITY
- PEDESTRIAN
- TRANSPORT
- CONFERENCES
- BOOK STORE
- MARKETPLACE
- GLOBAL WARM

Pedestrian Cities / Quality of Life

Market Trend Summary

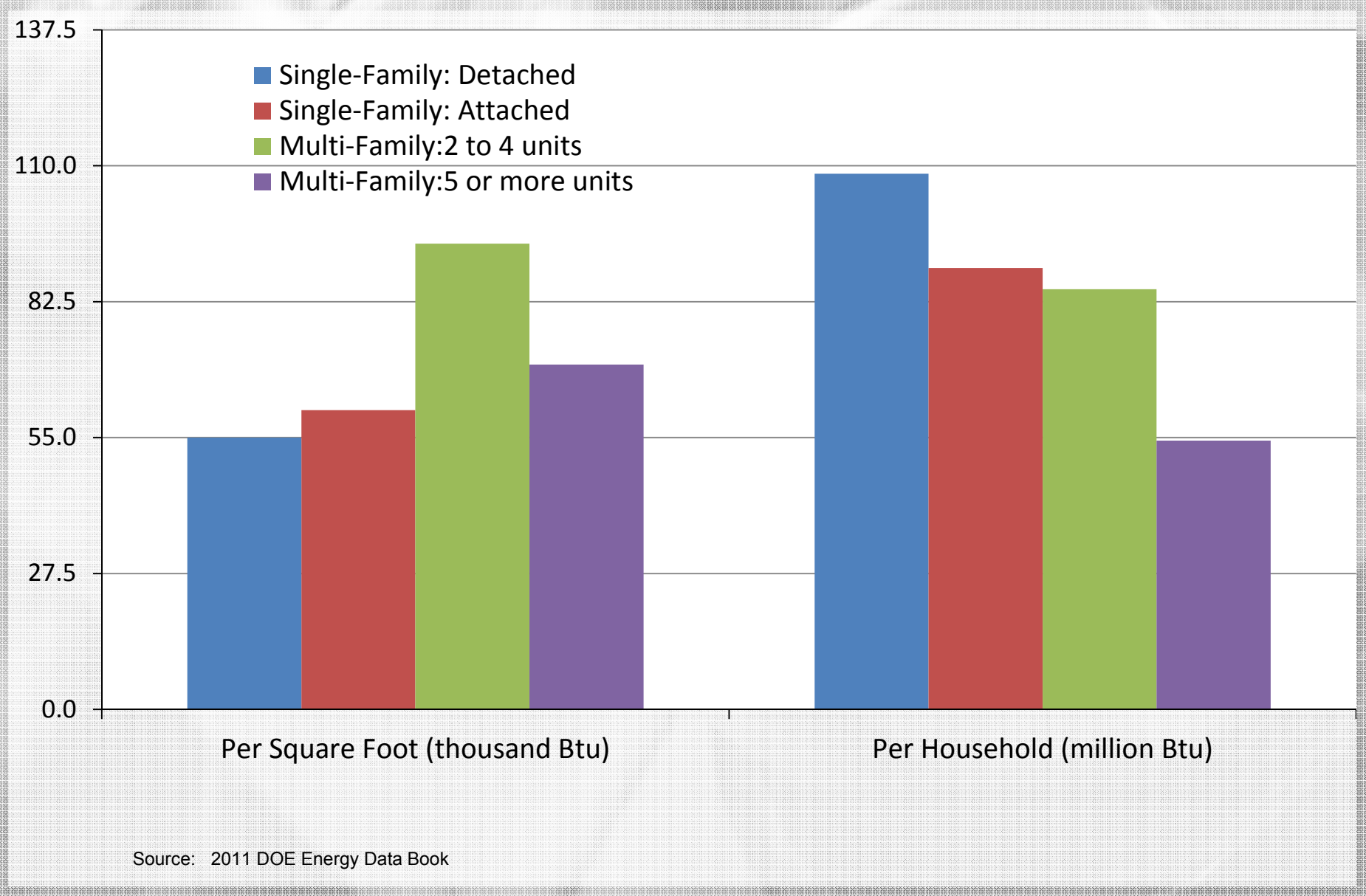
- Although residential construction in US is still primarily single-family, multi-family construction increasing faster than single family construction.
- Within multi-family construction, the number of floors is increasing.
- Trend to increasing multi-family construction fueled by
  - Increasing household rental vs. ownership
  - New urbanism.

ENERGY Consumption

"*The energy consumption profiles of single family homes and multi-family homes (apartments) are very different.*"

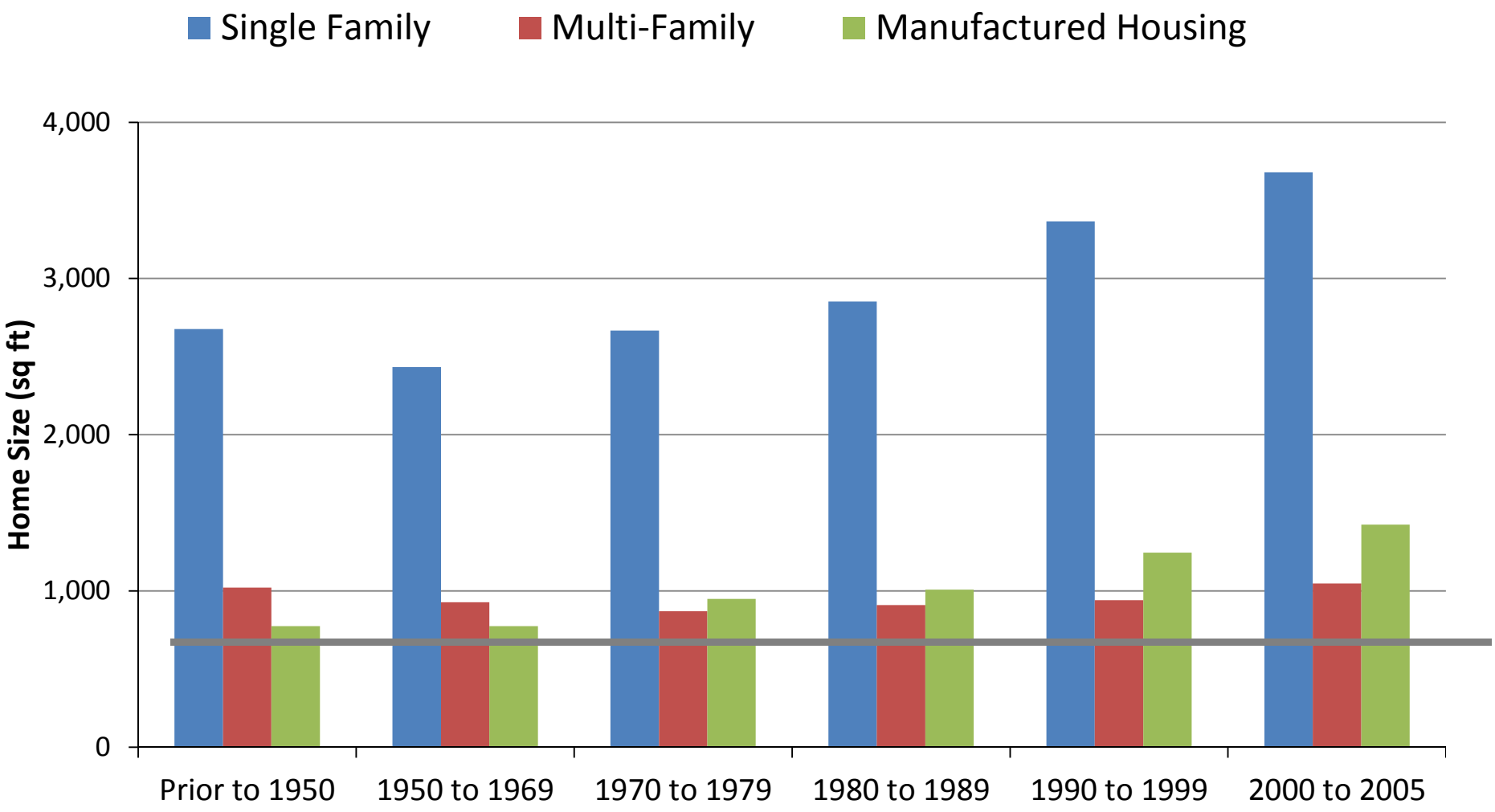
- US DOE Energy Data Book

Energy Usage by Building Type



Source: 2011 DOE Energy Data Book

Home Size by Building Type



Common Spaces & Common Payments

"the average energy distribution and associated costs per suite are as follows:

- *28% for suite electricity or $408 per year paid by the suite owner or occupant.*
- *21% for common area electricity or $323 per year paid by Strata Corporation.*
- *51% for gas (MAU space heat and DHW) or $455 per year paid by Strata Corporation.*

Of the per suite total of $1186 paid per year, 36% ($34 per month) is paid by the owner or occupant, and 64% ($65 per month) is paid by the Strata Corporation.

Clearly, the actual amount paid by the occupant is small and this disconnects the owner or occupant from the relative size of the total annual energy bill"

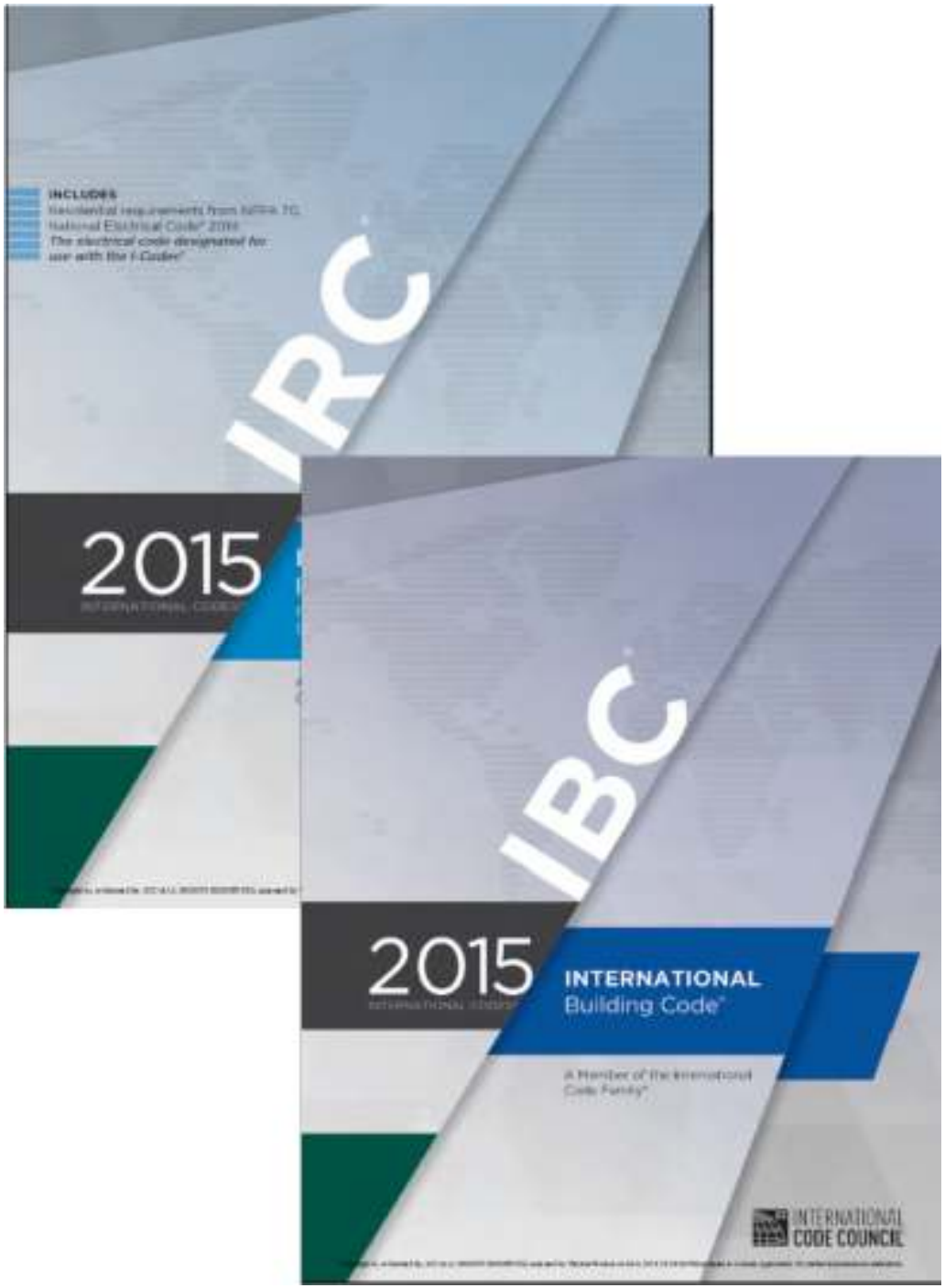
Graham Finch, MASc, Eric Burnett, PhD & Warren Knowles, P.Eng., "Energy Consumption in Mid and High Rise Residential Buildings in British Columbia", BEST2 Conference

Code Provisions

What Code Applies?
Building Occupancy & Type





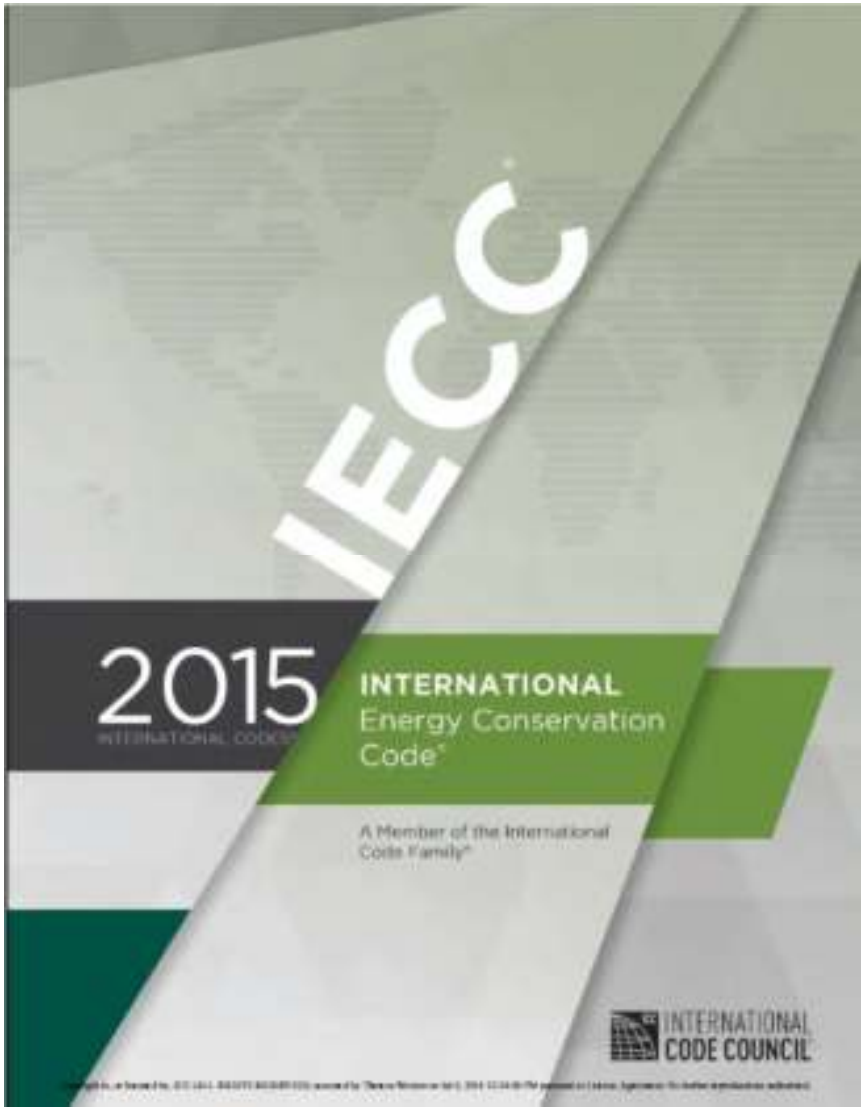


International Residential Code (IRC)

Detached one- and two-family dwellings and townhouses not more than three stories above *grade plane* in height with a separate means of egress and their *accessory structures*.

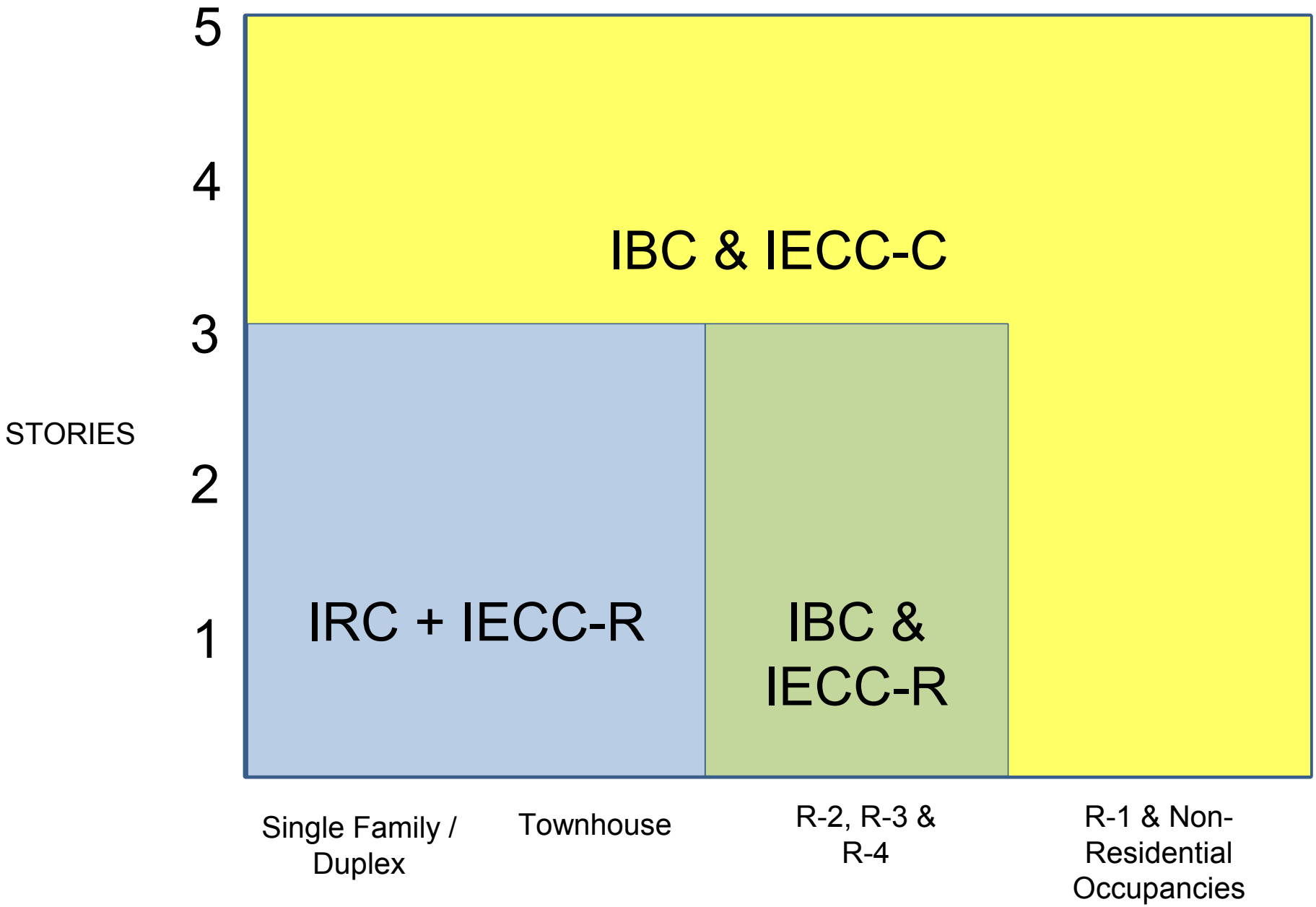
International Building Code (IBC):

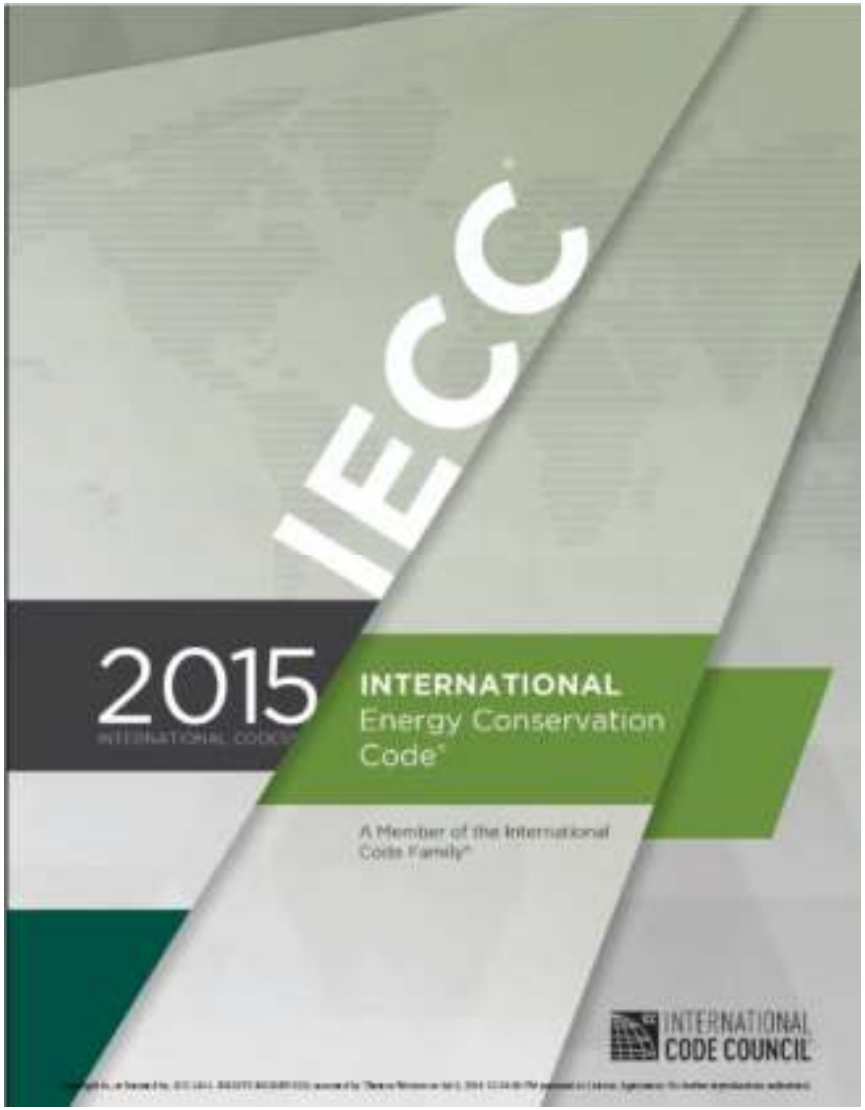
All other buildings



RESIDENTIAL BUILDING.
For this code, includes detached one- and two-family dwellings and multiple single family dwellings (townhouses) as well as Group R-2, R-3 and R-4 buildings three stories or less in height above grade plane.

COMMERCIAL BUILDING.
For this code, all buildings that are not included in the definition of “Residential buildings.”


5
4
3
2
1
STORIES
IBC & IECC-C
IRC + IECC-R
IBC &
IECC-R
Single Family /
Duplex
Townhouse
R-2, R-3 &
R-4
R-1 & Non-
Residential
Occupancies



Differences in Energy Provisions

IECC Residential – Compliance Paths

Prescriptive Path

Performance Path

Energy Rating Index Path (2015)

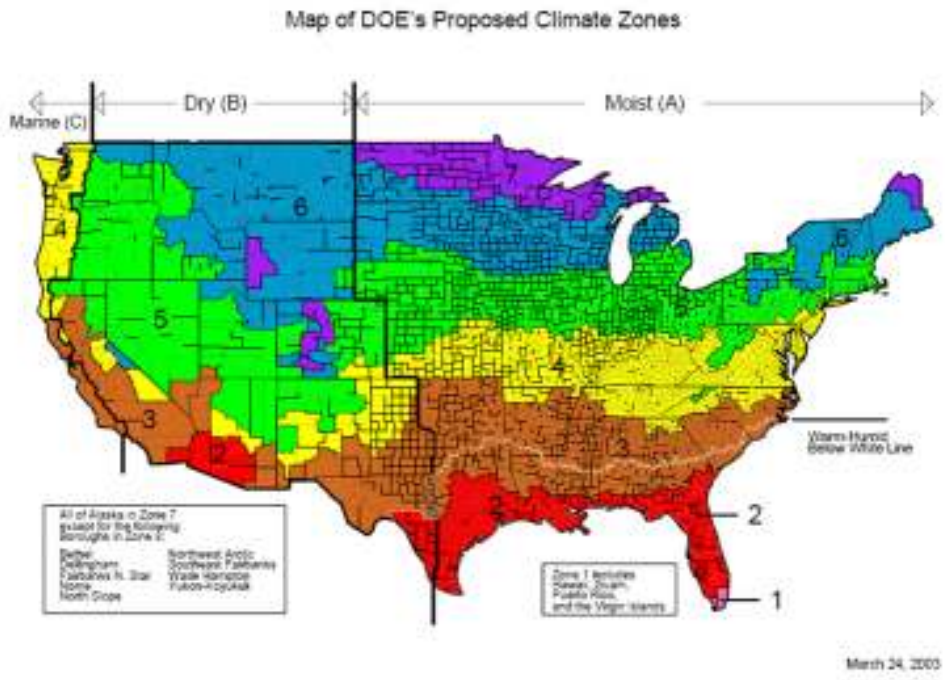
IECC Commercial – Compliance Paths

Prescriptive Path

Total Building Performance Path

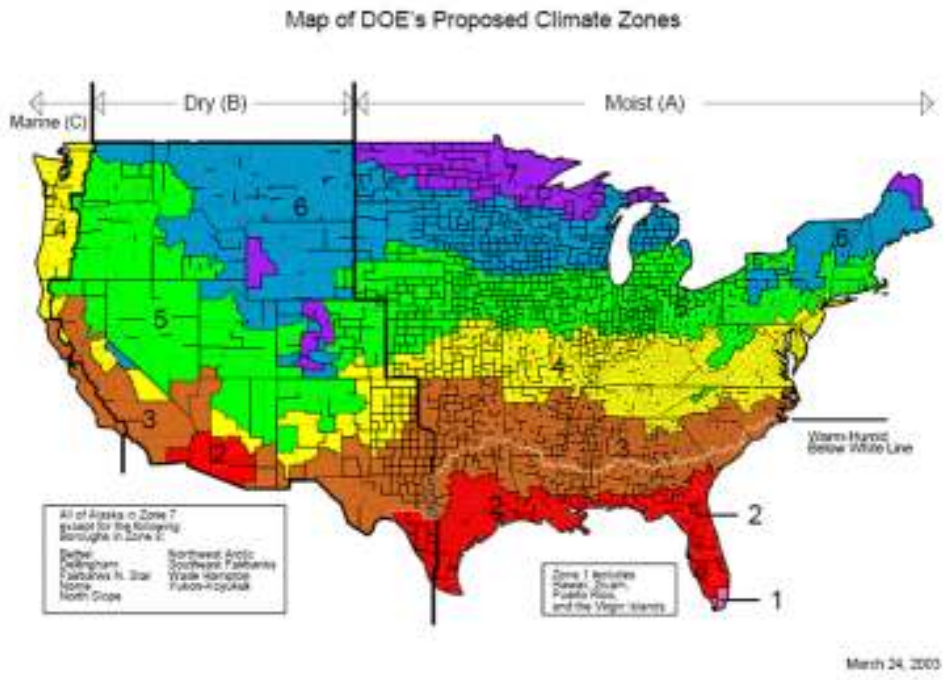
ANSI/ASHR AE/IESNA 90.1

R-value Requirements: Wood-Frame Wall



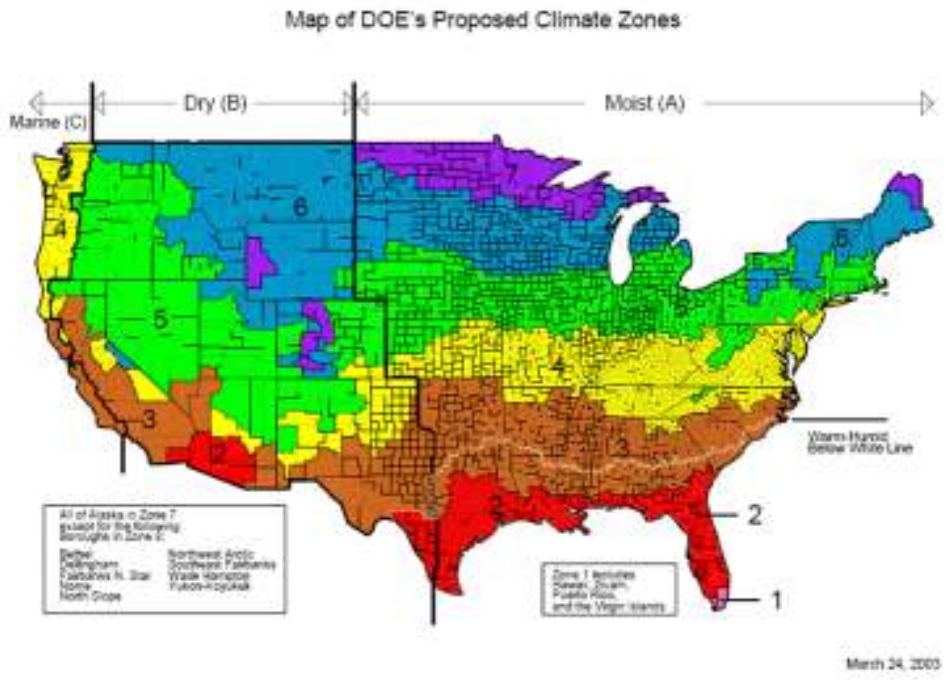
CLIMATE ZONE	2006 IECC RES	2006 IECC COM GRP R
1	13	13
2	13	13
3	13	13
4 X-MARINE	13	13
4 MARINE	19 or 13+5	13
5	19 or 13+5	13
6	19 or 13+5	13
7	21	13
8	21	13+7.5ci

R-value Requirements: Wood-Frame Wall



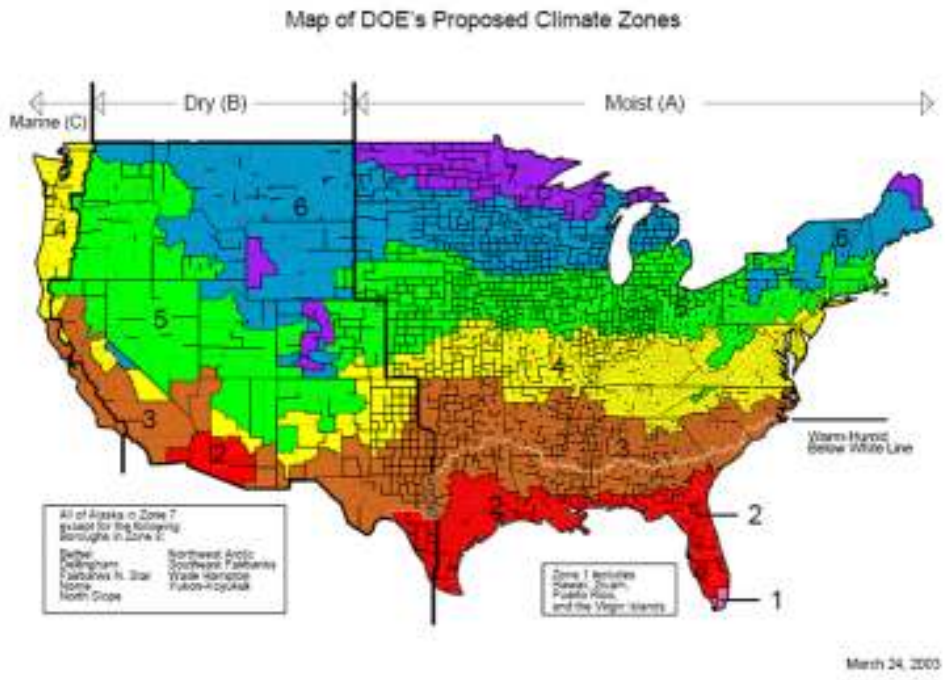
CLIMATE ZONE	2009 IECC RES	2009 IECC COM GRP R
1	13	13
2	13	13
3	13	13
4 X-MARINE	13	13+3.8ci
4 MARINE	20 or 13+5	13+3.8ci
5	20 or 13+5	13+3.8ci
6	20 or 13+5	13+7.5ci
7	21	13+7.5ci
8	21	13+15.6ci

R-value Requirements: Wood-Frame Wall



CLIMATE ZONE	2012 IECC RES	2012 IECC COM GRP R
1	13	20 or 13+3.8ci
2	13	20 or 13+3.8ci
3	20 or 13+5	20 or 13+3.8ci
4 X-MARINE	20 or 13+5	20 or 13+3.8ci
4 MARINE	20 or 13+5	13+7.5ci or 20+3.8ci
5	20 or 13+5	13+7.5ci or 20+3.8ci
6	20+5 or 13+10	13+7.5ci or 20+3.8ci
7	20+5 or 13+10	13+7.5ci or 20+3.8ci
8	20+5 or 13+10	13+15.6ci or 20+10ci

R-value Requirements: Wood-Frame Wall



CLIMATE ZONE	2015 IECC RES	2015 IECC COM GRP R
1	13	20 or 13+3.8ci
2	13	20 or 13+3.8ci
3	20 or 13+5	20 or 13+3.8ci
4 X-MARINE	20 or 13+5	20 or 13+3.8ci
4 MARINE	20 or 13+5	13+7.5ci or 20+3.8ci
5	20 or 13+5	13+7.5ci or 20+3.8ci
6	20+5 or 13+10	13+7.5ci or 20+3.8ci
7	20+5 or 13+10	13+7.5ci or 20+3.8ci
8	20+5 or 13+10	13+15.6ci or 20+10ci

IECC Air Leakage Requirements - 2015

Residential

2009 – Option

Checklist or BD

2012 & 2015 Required

Checklist and BD

and

Commercial

2015 – 3 Options

Material Testing

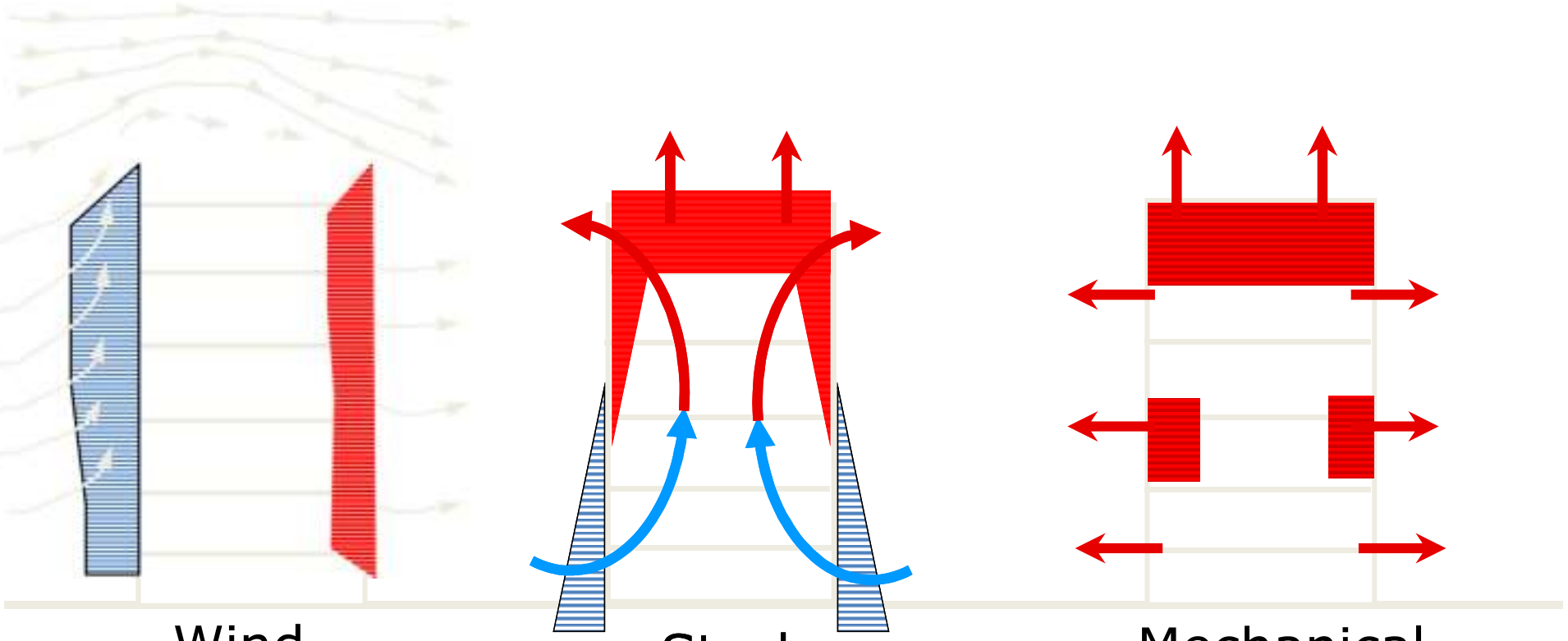
or

Assembly Testing

or

Whole Building Testing

Sources of Air Pressure Difference (ΔP)

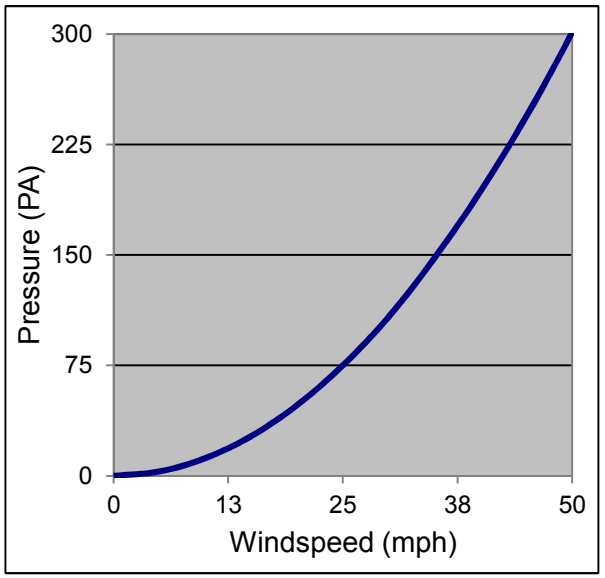


Wind Pressure

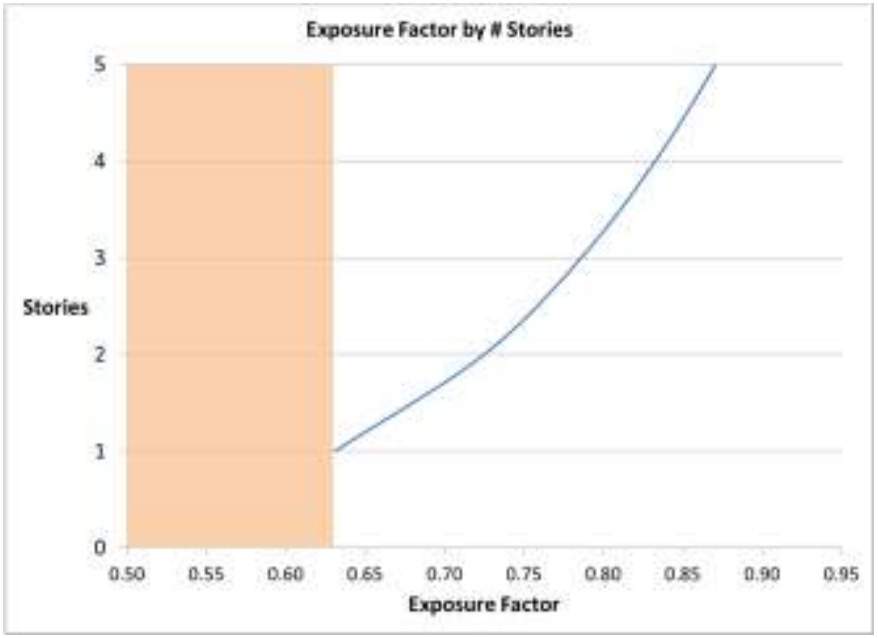
Stack Pressure

Mechanical Pressure

Wind Pressure



Height Exposure Factor = (height in stories/10)$^{1/5}$



Stack Pressure

$$\Delta p_s = 0.00598(\rho_o - \rho_i)g(H_{NPL} - H)$$

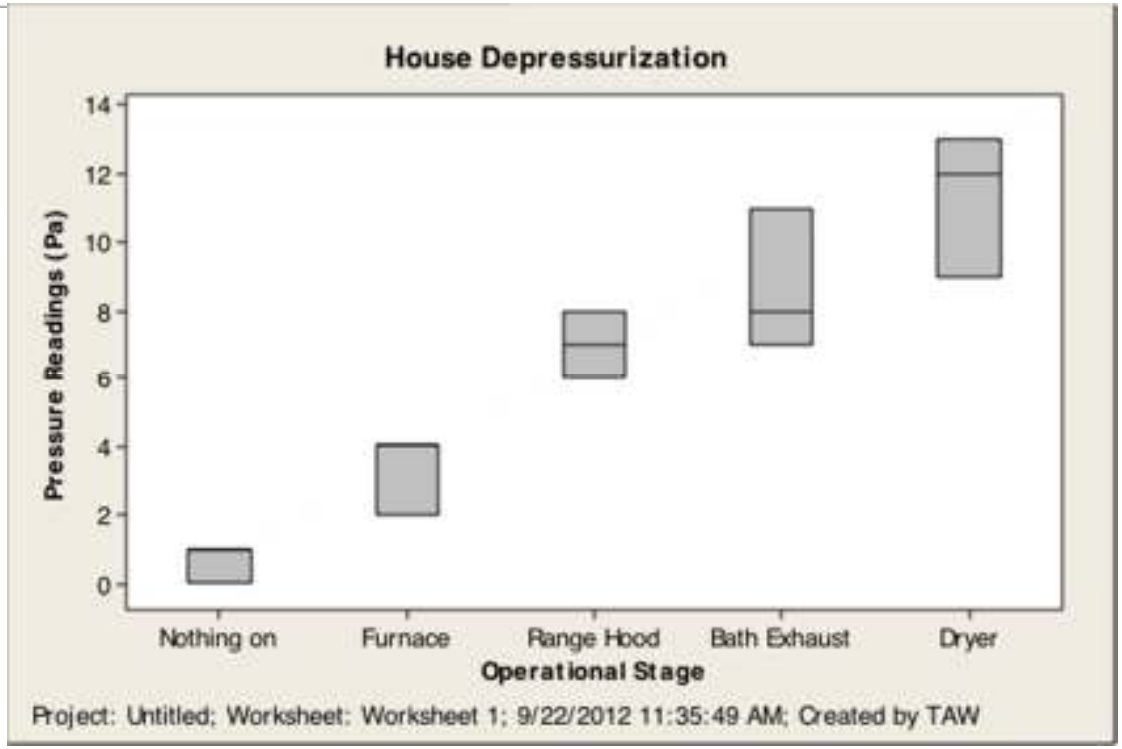
$$= 0.00598\rho_o\left(\frac{T_i - T_o}{T_i}\right)g(H_{NPL} - H)$$

where

T_o = outdoor temperature, °R
T_i = indoor temperature, °R
ρ_o = outdoor air density, lb/ft^3
ρ_i = indoor air density, lb/ft^3
H_{NPL} = height of neutral pressure level above reference plane without any other driving forces, ft

Source: 2009 ASHRAE Handbook of Fundamentals.

Hous



Source: Weston, T. A. *et. al*. ,"Preliminary Investigation of Moisture in Walls of Manufactured Homes" presented at the Conference on Durability and Disaster Mitigation in Wood-Frame Housing, Madison, WI, October, 2001

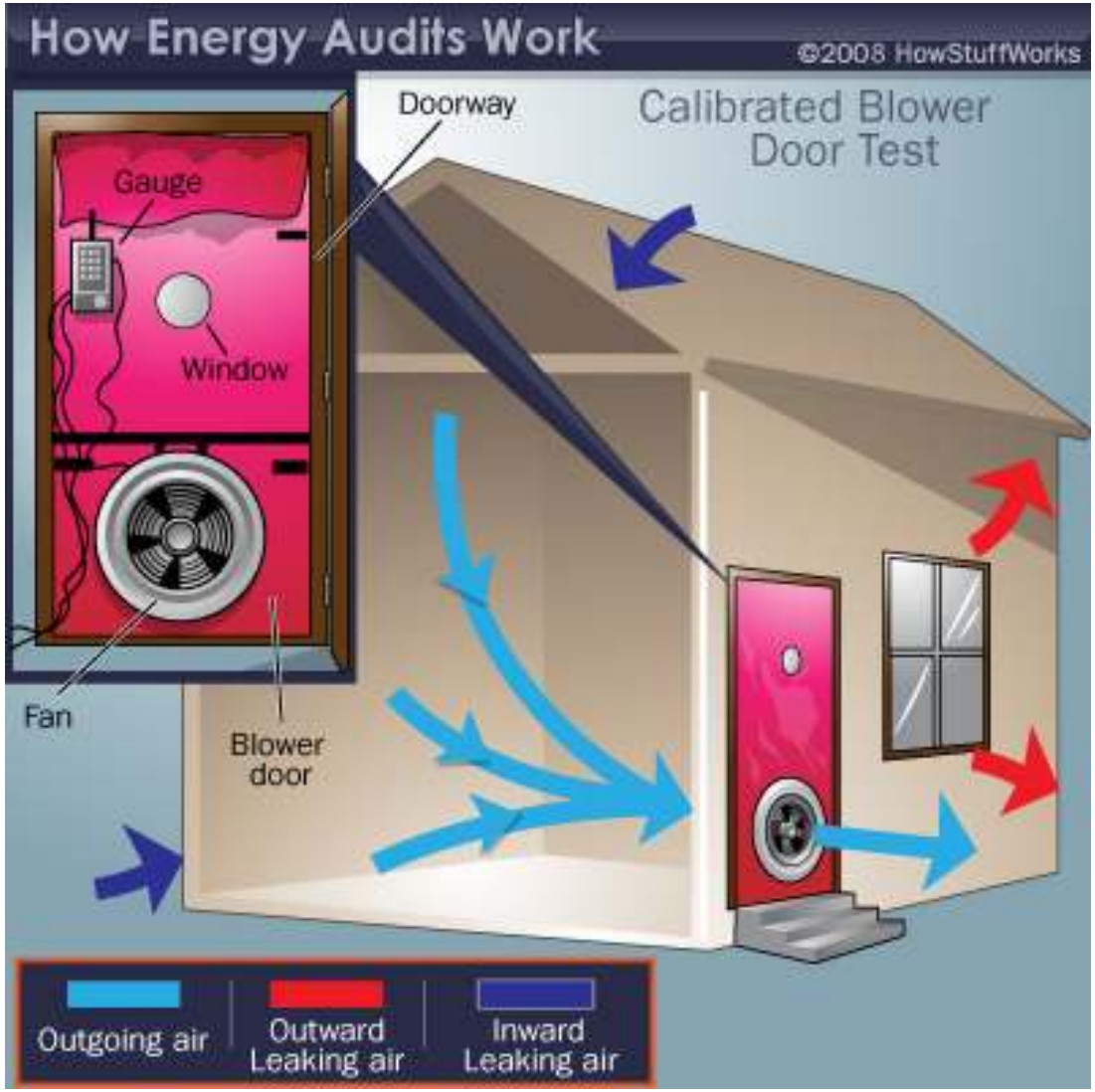
TABLE R402.4.1.1
AIR BARRIER AND INSULATION INSTALLATION

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
General requirements	A continuous air barrier shall be installed in the building envelope. The exterior thermal envelope contains a continuous air barrier. Breaks or joints in the air barrier shall be sealed.	Air-permeable insulation shall not be used as a sealing material.
Ceiling/attic	The air barrier in any dropped ceiling/soffit shall be aligned with the insulation and any gaps in the air barrier shall be sealed. Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed.	The insulation in any dropped ceiling/soffit shall be aligned with the air barrier.
Walls	The junction of the foundation and sill plate shall be sealed. The junction of the top plate and the top of exterior walls shall be sealed. Knee walls shall be sealed.	Cavities within corners and headers of frame walls shall be insulated by completely filling the cavity with a material having a thermal resistance of R-3 per inch minimum. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier.
Windows, skylights and doors	The space between windows/door jambs and framing, and skylights and framing shall be sealed.	
Rim joists	Rim joists shall include the air barrier.	Rim joists shall be insulated.
Floors (including above garage and cantilevered floors)	The air barrier shall be installed at any exposed edge of insulation.	Floor framing cavity insulation shall be installed to maintain permanent contact with the underside of subfloor decking, or floor framing cavity insulation shall be permitted to be in contact with the top side of sheathing, or continuous insulation installed on the underside of floor framing and extends from the bottom to the top of all perimeter floor framing members.
Crawl space walls	Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder with overlapping joints taped.	Where provided instead of floor insulation, insulation shall be permanently attached to the crawlspace walls.
Shafts, penetrations	Duct shafts, utility penetrations, and flue shafts opening to exterior or unconditioned space shall be sealed.	
Narrow cavities		Batts in narrow cavities shall be cut to fit, or narrow cavities shall be filled by insulation that on installation readily conforms to the available cavity space.
Garage separation	Air sealing shall be provided between the garage and conditioned spaces.	
Recessed lighting	Recessed light fixtures installed in the building thermal envelope shall be sealed to the drywall.	Recessed light fixtures installed in the building thermal envelope shall be air tight and IC rated.
Plumbing and wiring		Batt insulation shall be cut neatly to fit around wiring and plumbing in exterior walls, or insulation that on installation readily conforms to available space shall extend behind piping and wiring.
Shower/tub on exterior wall	The air barrier installed at exterior walls adjacent to showers and tubs shall separate them from the showers and tubs.	Exterior walls adjacent to showers and tubs shall be insulated.
Electrical/phone box on exterior walls	The air barrier shall be installed behind electrical or communication boxes or air-sealed boxes shall be installed.	
HVAC register boots	HVAC register boots that penetrate building thermal envelope shall be sealed to the subfloor or drywall.	
Concealed sprinklers	When required to be sealed, concealed fire sprinklers shall only be sealed in a manner that is recommended by the manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.	

a. In addition, inspection of log walls shall be in accordance with the provisions of ICC-400.

Residential Air Barrier and Insulation Installation

Whole Building Tests

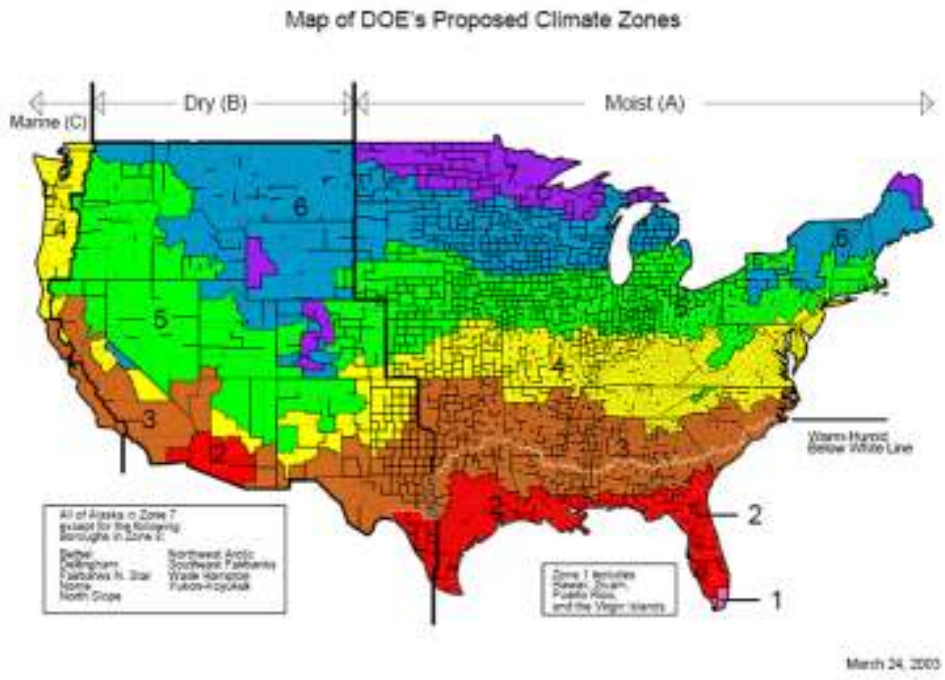


R402.4.1.2 Testing. The building or dwelling unit shall be tested and verified as having an air leakage rate not exceeding five air changes per hour in Climate Zones 1 and 2, and three air changes per hour in Climate Zones 3 through 8. Testing shall be conducted in accordance with ASTM E 779 or ASTM E 1827 and reported at a pressure of 0.2 inch w.g. (50 Pascals). Where required by the code official, testing shall be conducted by an approved third party. A written report of the results of he test shall be signed by the party conducting the test and provided to the code official. Testing shall be performed at any time after creation of all penetrations of the building thermal envelope. During testing:

1. Exterior windows and doors, fireplace and stove doors shall be closed, but not sealed, beyond the intended weather-stripping or other infiltration control measures.
2. Dampers including exhaust, intake, makeup air, backdraft and flue dampers shall be closed, but not sealed beyond intended infiltration control measures.
3. Interior doors, if installed at the time of the test, shall be open.
4. Exterior doors for continuous ventilation systems and heat recovery ventilators shall be closed and sealed.
5. Heating and cooling systems, if installed at the time of the test, shall be turned off.
6. Supply and return registers, if installed at the time of the test, shall be fully open..

C402.5 Air leakage—thermal envelope (Mandatory). The thermal envelope of buildings shall comply with Sections C402.5.1 through C402.5.8, or the building thermal envelope shall be tested in accordance with ASTM E 779 at a pressure differential of 0.3 inch water gauge (75 Pa) or an equivalent method approved by the code official and deemed to comply with the provisions of this section when the tested air leakage rate of the building thermal envelope is not greater than 0.40 cfm/ft2 (0.2 L/s · m2).

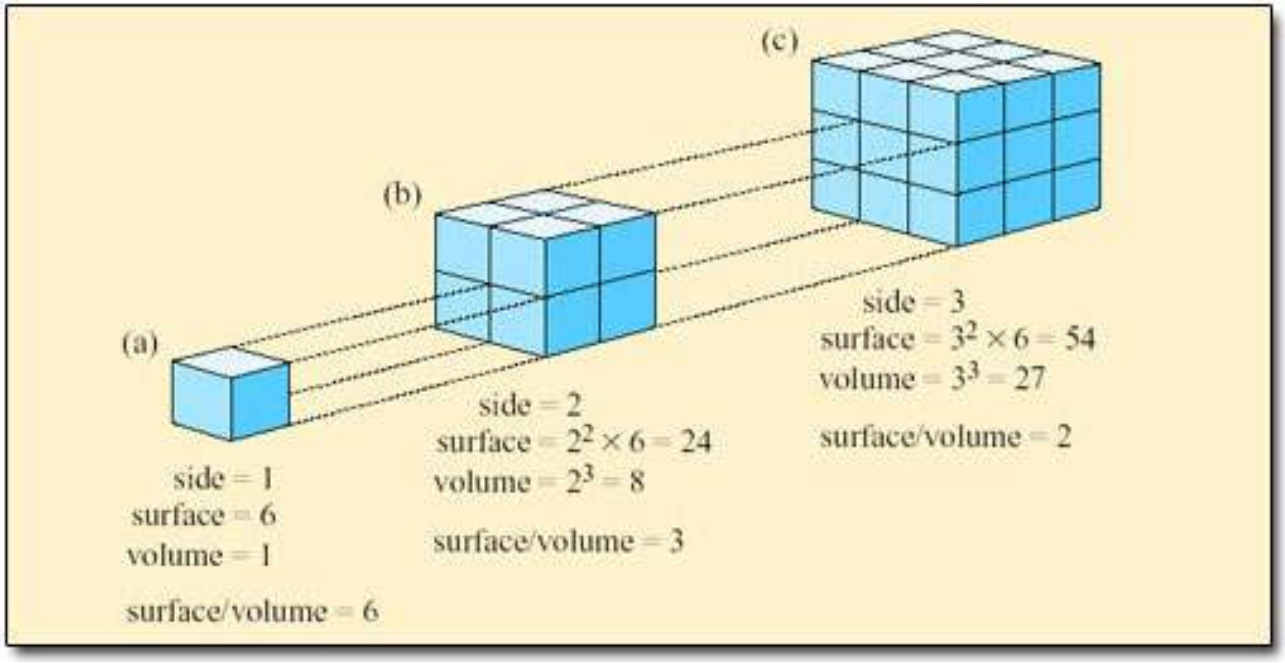
Air Leakage Requirements



CLIMATE ZONE	2012 IECC RES	2012 IECC COM
1	5 ACH_{50}	Air barrier not required
2	5 ACH_{50}	Air barrier not required
3	3 ACH_{50}	Air barrier not required
4 X-MARINE	3 ACH_{50}	**0.40 cfm/ft²**
4 MARINE	3 ACH_{50}	**0.40 cfm/ft²**
5	3 ACH_{50}	**0.40 cfm/ft²**
6	3 ACH_{50}	**0.40 cfm/ft²**
7	3 ACH_{50}	**0.40 cfm/ft²**
8	3 ACH_{50}	**0.40 cfm/ft²**

CFM / ft^2 of building envelope

ACH50 = 60 CFM / (Building Volume)



Air Barrier Test Methods and Usage

	Product Testing	Assembly Testing	As-built Testing
			 79,
ABAA Certification	≤ .004 cfm/ft² at .3 in.H_2O (≤ .02 L/(s•m²) @75 Pa) **&**	≤ .04 cfm/ft² at .3 in.H_2O (≤ .2 L/(s•m²)@75 Pa)	
IECC(2012) Residential			≤ 5 ACH_{50} (Climate Zones 1&2) ≤ 3 ACH_{50} (Climate Zones 3 - 8)
IECC (2012) Commercial	≤ .004 cfm/ft² at .3 in.H_2O (≤ .02 L/(s•m²) @75 Pa)	≤ .04 cfm/ft² at .3 in.H_2O (≤ .2 L/(s•m²)@75 Pa)	≤ .4 cfm/ft² at .3 in.H_2O
USACE Specification	≤ .004 cfm/ft² at .3 in.H_2O (≤ .02 L/(s•m²) @75 Pa)	**&**	≤ .25 cfm/ft² at .3 in.H_2O (modified by USACE protocol)


IBC
2015
INTERNATIONAL
Building Code
A Member of the International Code Family
IRC
INCLUDES
2015
INTERNATIONAL
Residential Code
FOR ONE- AND TWO-FAMILY DWELLINGS
A Member of the International Code Family
INTERNATIONAL CODE COUNCIL

IBC: Construction Types

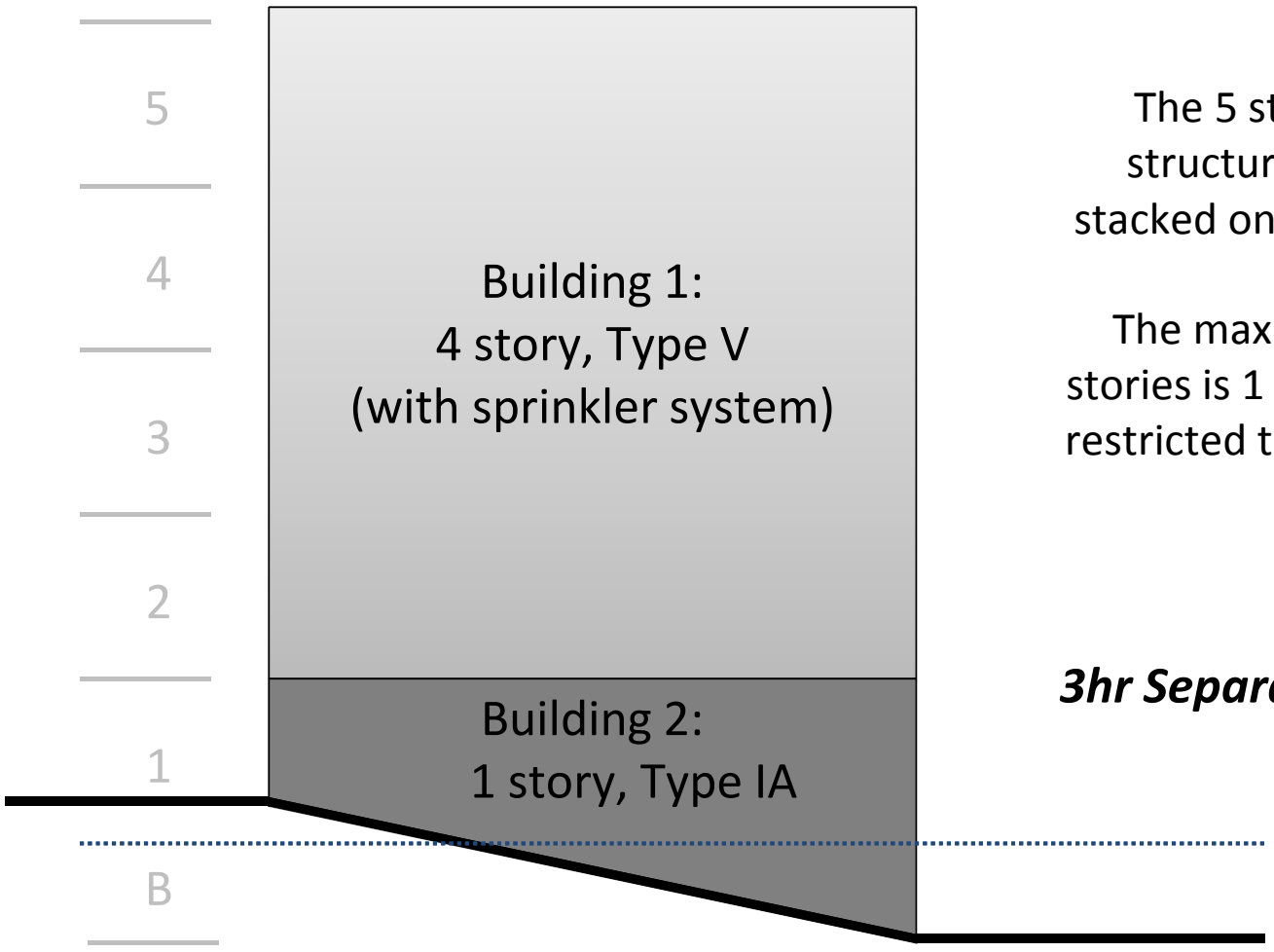
	Type I	Non-Combustible Exterior, Components, and Structure
	Type II	Non-Combustible Exterior and Components
	Type III	Non-Combustible Exterior
	Type IV	Heavy Timber Construction
	Type V	Combustible Construction

Maximum Building Height (IBC Table 503)

Including 1-story sprinkler system increase

Building Use	Type V Combustible	Type IV Heavy Timber	Type III Non-Combustible Exterior	Type II Non-Combustible Components	Type I Fire-Rated Structure
Residential (IRC)					
Residential	3	n/a	n/a	n/a	n/a
Commercial (IBC)**					
Assembly***	3	4	4	4	Unlimited
Education	2	4	4	4	Unlimited
Business	4	6	6	6	Unlimited
Factory/Ind	4	6	5	6	Unlimited
High Hazard	4	6	6	6	Unlimited
Institutional	3	5	5	5	Unlimited
Mercantile	4	5	5	5	Unlimited
Residential	4	5	5	5	Unlimited
Storage	5	6	5	6	Unlimited
Utility	3	5	4	5	Unlimited

Mixed Construction: Platform/ odium



The 5 story “podium” residential structure is really two “buildings” stacked on top of each other (IBC 510).

The maximum number of ‘podium’ stories is 1 and the overall height is still restricted to the use’s maximum height per IBC Table 503

3hr Separation

Imaginary line for fire separation.

Austin, TX
Construction Type: IA/VA

Andrea Leptinsky, www.impactnews.com

Austin, TX

Construction Type: IA/VA

Mixed Construction: “Imaginary” lot line

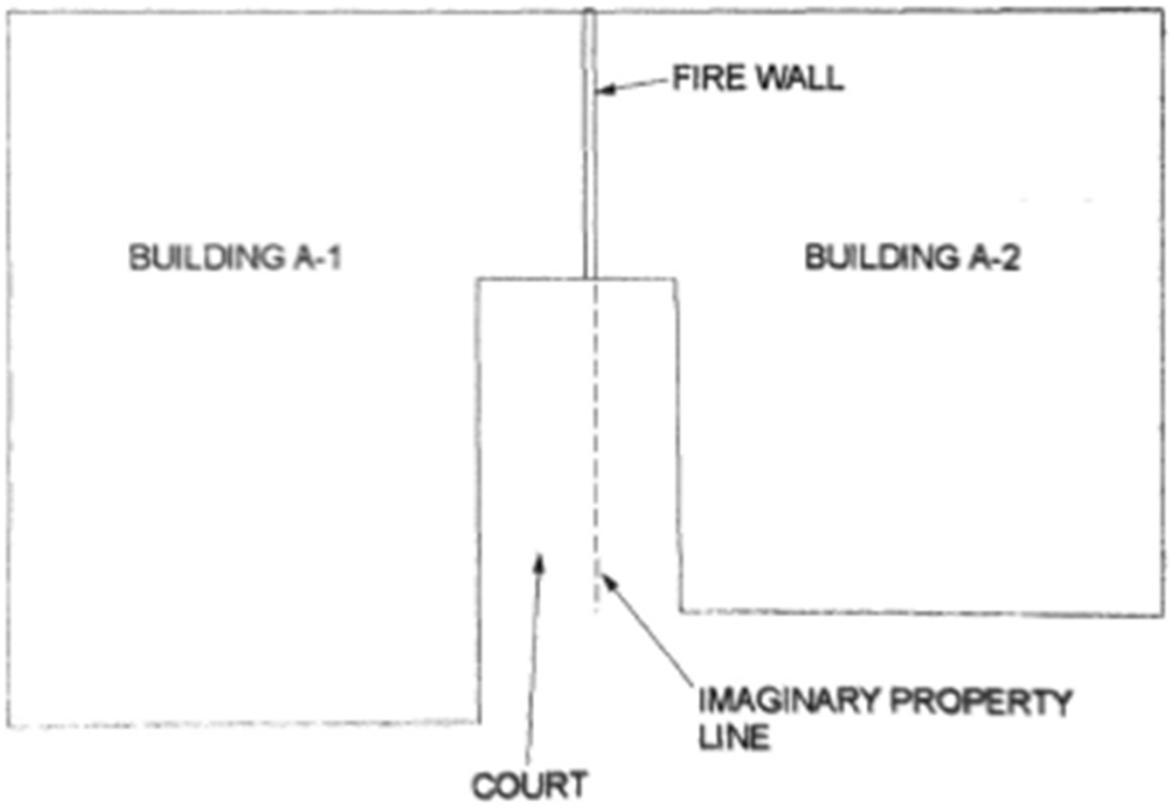


Figure 503.1.2(2)
TWO BUILDINGS ON SAME LOT CREATED BY FIRE WALL

Fire Resistance

International Residential Code (IRC-2015)

R302.10 Flame spread index and smoke-developed index for insulation. Flame spread and smoke-developed index for insulation shall be in accordance with Sections R302.10.1 through R302.10.5.

R302.10.1 Insulation. Insulation materials, including facings, such as vapor retarders and vapor-permeable membranes installed within floor-ceiling assemblies, roof ceiling assemblies, wall assemblies, crawl spaces and attics shall have a flame spread index not to exceed 25 with an accompanying smoke-developed index not to exceed 450 where tested in accordance with ASTM E 84 or UL 723.

Exceptions:

1. Where such materials are installed in concealed spaces, the flame spread index and smoke-developed index limitations do not apply to the facings, provided that the facing is installed in substantial contact with the unexposed surface of the ceiling, floor or wall finish.

2. Cellulose fiber loose-fill insulation, that is not spray applied, complying with the requirements of Section R302.10.3, shall not be required to meet the smoke-developed index of not more than 450 and shall be required to meet a smoke developed index of not more than 450 where tested in accordance with CAN/ULC S102.2.

3. Foam plastic insulation shall comply with Section R316.

R316.3 Surface burning characteristics. Unless otherwise allowed in Section R316.5, foam plastic or foam plastic cores used as a component in manufactured assemblies used in building construction shall have a flame spread index of not more than 75 and shall have a smoke developed index of not more than 450 when tested in the maximum thickness and density intended for use in accordance with ASTM E 84 or UL 723. Loose-fill-type foam plastic insulation shall be tested as board stock for the flame spread index and smoke developed index.

Exception: Foam plastic insulation more than 4 inches (102 mm) thick shall have a flame spread index of not more than 75 and a smoke-developed index of not more than 450 where tested at a thickness of not more than 4 inches (102 mm), provided that the end use is approved in accordance with Section R316.6 using the thickness and density intended for use.

International Building Code (IBC-2015)

SECTION 720 THERMAL- AND SOUND-INSULATING MATERIALS

720.1 General. Insulating materials, including facings such as vapor retarders and *vapor-permeable membranes*, similar coverings and all layers of single and multilayer reflective foil insulations, shall comply with the requirements of this section. Where a flame spread index or a smoke-developed index is specified in this section, such index shall be determined in accordance with ASTM E 84 or UL 723. Any material that is subject to an increase in flame spread index or smoke-developed index beyond the limits herein established through the effects of age, moisture or other atmospheric conditions shall not be permitted.

Exceptions:

1. Fiberboard insulation shall comply with Chapter 23.

2. Foam plastic insulation shall comply with Chapter 26.

3. Duct and pipe insulation and duct and pipe coverings and linings in plenums shall comply with the *International Mechanical Code*.

4. All layers of single and multilayer reflective plastic core insulation shall comply with Section 2613.

720.2 Concealed installation. Insulating materials, where concealed as installed in buildings of any type of construction, shall have a flame spread index of not more than 25 and a smoke-developed index of not more than 450.

Exception: Cellulosic fiber loose-fill insulation complying with the requirements of Section 720.6 shall not be required to meet a flame spread index requirement but shall be required to meet a smoke-developed index of not more than 450 when tested in accordance with CAN/ULC S102.2.

720.2.1 Facings. Where such materials are installed in concealed spaces in buildings of Type III, IV or V construction, the flame spread and smoke-developed limitations do not apply to facings, coverings, and layers of reflective foil insulation that are installed behind and in substantial contact with the unexposed surface of the ceiling, wall or floor finish.

Exception: All layers of single and multilayer reflective plastic core insulation shall comply with Section 2613.

2603.3 Surface-burning characteristics. Unless otherwise indicated in this section, foam plastic insulation and foam plastic cores of manufactured assemblies shall have a flame spread index of not more than 75 and a smoke-developed index of not more than 450 where tested in the maximum thickness intended for use in accordance with ASTM E 84 or UL 723. Loose fill-type foam plastic insulation shall be tested as board stock for the flame spread and smoke-developed indexes.

Exceptions:

1. Smoke-developed index for interior *trim* as provided for in Section 2604.2.

2. In cold storage buildings, ice plants, food plants, food processing rooms and similar areas, foam plastic insulation where tested in a thickness of 4 inches (102 mm) shall be permitted in a thickness up to 10 inches (254 mm) where the building is equipped throughout with an automatic fire sprinkler system in accordance with Section 903.3.1.1. The approved *automatic sprinkler system* shall be provided in both the room and that part of the building in which the room is located.

3. Foam plastic insulation that is a part of a Class A, B or C roof-covering assembly provided the assembly with the foam plastic insulation satisfactorily passes NFPA 276 or UL 1256. The smoke-developed index shall not be limited for roof applications.

4. Foam plastic insulation greater than 4 inches (102 mm) in thickness shall have a maximum flame spread index of 75 and a smoke-developed index of 450 where tested at a minimum thickness of 4 inches (102 mm), provided the end use is approved in accordance with Section 2603.10 using the thickness and density intended for use.

5. Flame spread and smoke-developed indexes for foam plastic interior signs in *covered and open mall buildings* provided the signs comply with Section 402.6.4.

NFPA 285: Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load Bearing Wall Assemblies Containing Combustible Components.

- Tests fire performance of the wall assembly to be used on a project.
  - Required by code when certain “combustible” materials are specified to be used in a “non-combustible” wall assembly
  - Applies to exterior walls of Type I-IV Construction
- Triggered by when specific combustible materials are specified components of the wall assembly:
  - Combustible insulation (pre-2012 IBC)
  - Combustible claddings (pre-2012 IBC & 2012 IBC)
  - Combustible air & water barriers (2012 IBC)

NFPA 285 “Triggers”

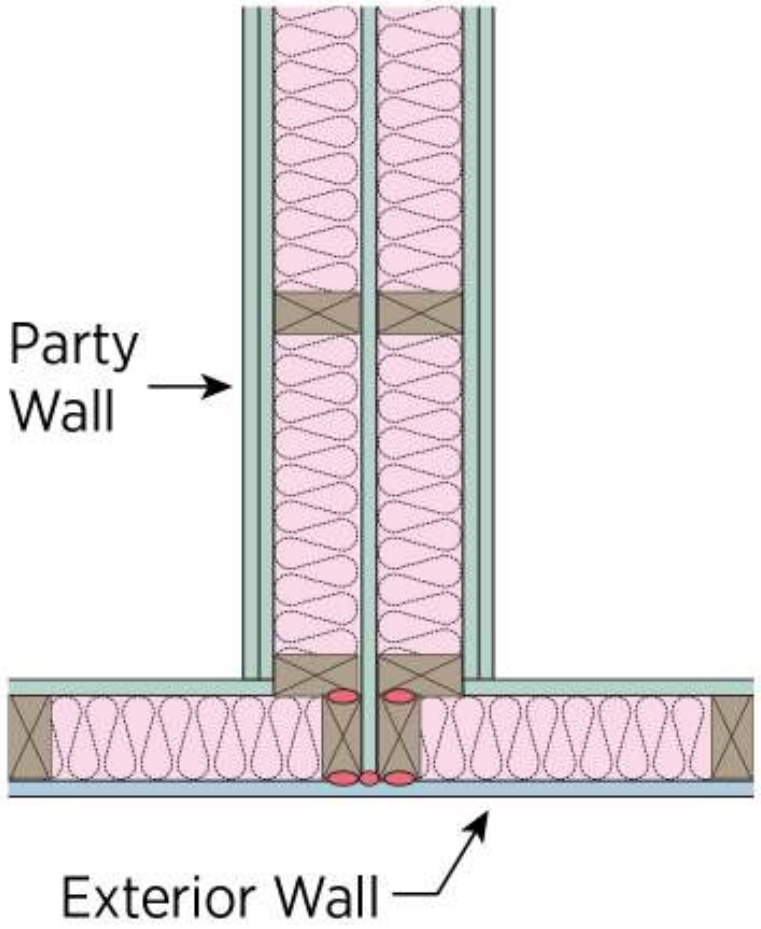
2006	2009	2012
		Mechanical equipment screens located on roof decks constructed of combustible materials (1509.6.2)
		High-Pressure Decorative Exterior-Grade Compact Laminates (HPL) used as exterior wall coverings (1409.10.4)
	Fiber-reinforced polymer (FRP) used on exterior walls (2612.6)	Fiber-reinforced polymer (FRP) used on exterior walls (2612.5)
Metal composite materials (MCM), such as ACM, used as exterior wall coverings (1407.10.4)	Metal composite materials (MCM), such as ACM, used as exterior wall coverings (1407.10.4)	Metal composite materials (MCM), such as ACM, used as exterior wall coverings (1407.10.4)
Foam plastic insulation (2603.5.5)	Foam plastic insulation (2603.5.5)	Foam plastic insulation (2603.5.5)
		Combustible water resistive barrier (1403.5)

International Residential Code (IRC-2015)

R302.2 Townhouses. Common walls separating townhouses shall be assigned a fire-resistance rating in accordance with Section R302.2, Item 1 or 2. The common wall shared by two townhouses shall be constructed without plumbing or mechanical equipment, ducts or vents in the cavity of the common wall. The wall shall be rated for fire exposure from both sides and shall extend to and be tight against exterior walls and the underside of the roof sheathing. Electrical installations shall be in accordance with Chapters 34 through 43. Penetrations of the membrane of common walls for electrical outlet boxes shall be in accordance with Section R302.4.

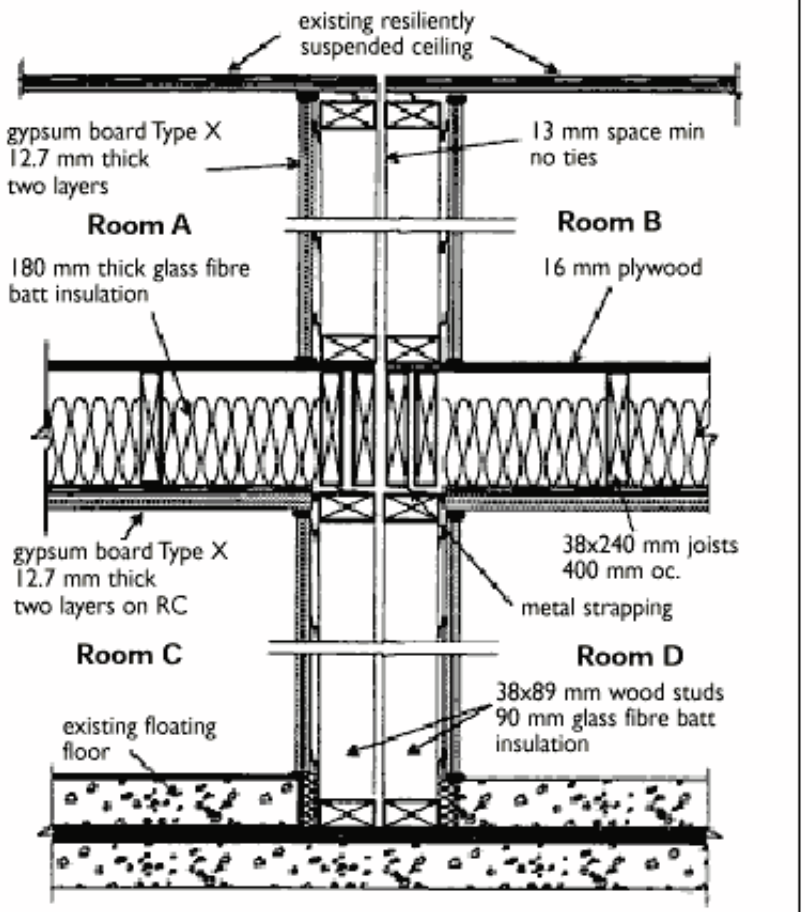
1. Where a fire sprinkler system in accordance with Section P2904 is provided, the common wall shall be not less than a 1-hour fire-resistance-rated wall assembly tested in accordance with ASTM E 119 or UL 263.

2. Where a fire sprinkler system in accordance with Section P2904 is not provided, the common wall shall be not less than a 2-hour fire-resistance-rated wall assembly tested in accordance with ASTM E119 or UL 263.



International Building Code (IBC-2015)

Figure 2: Section through the party wall



Separation Walls

706.1 General. Each portion of a building separated by one or more *fire walls* that comply with the provisions of this section shall be considered a separate building. The extent and location of such *fire walls* shall provide a complete separation Where a *fire wall* also separates occupancies that are required to be separated by a *fire barrier* wall, the most restrictive requirements of each separation shall apply.

706.1.1 Party walls. Any wall located on a *lot line* between adjacent buildings, which is used or adapted for joint service between the two buildings, shall be constructed as a *fire wall* in accordance with Section 706. Party walls shall be constructed without openings and shall create separate buildings.

Water Management

Nationally, construction defect losses run into the billions

- 69% of all construction defect claims are related to moisture penetration through the building envelope (2007 Study by University of Florida)
- The availability of general liability insurance for homebuilders and subcontractors has become increasingly limited and more expensive
  - *"The companies are finding it more difficult than five years ago to tap insurance to cover payments to homeowners because insurers have added so many exceptions, said Dave Stern, vice president at West Coast Casualty Service Inc., an insurance adjuster in Westlake Village, California. In California, "basically, the thing leaks, it's the builder that's liable," Stern said."*
- Some moisture problems are blamed on increasing energy efficiency
  - *"Building codes adopted in the 1970s and strengthened through the '80s and early '90s, required greater energy efficiency. Paradoxically, the demise of the drafty house had an unintended consequence: When moisture penetrates today's walls, they tend to stay wet."*

Sources: "Building Defects Spoil Homeowners' Dreams, The Oregonian, June 19, 2005; "Homebuilder Shares Undermined by Creeping Costs of Construction Boom Flaws", Bloomberg, February 10, 2011; Grosskopf and Lucas, "Identifying the Causes of Moisture-Related Defect Litigation in U.S.Building Construction", COBRA 2008 The construction and building research conference of the Royal Institution of Chartered Surveyors, Dublin Institute of Technology, 4-5 September 2008.

Rating of Moisture Sources in Buildings

Bulk Water

- Rain & Snow:
- (above grade envelope)

1 → >>1,000X

Water Vapor

Transported by air currents — 98% — 2 → 100X

Diffusion — 2% — 3 → 1X

Managing Bulk Water

- Redundancy – Cladding + Second Line of Defense
  - Water-resistive barriers
  - Flashing
- Material Choice
  - Performance – Water & Resistance
  - Allow Drying
  - Durability
- Installation -- Continuity
  - Shingling correctly
  - Beware of hidden water traps

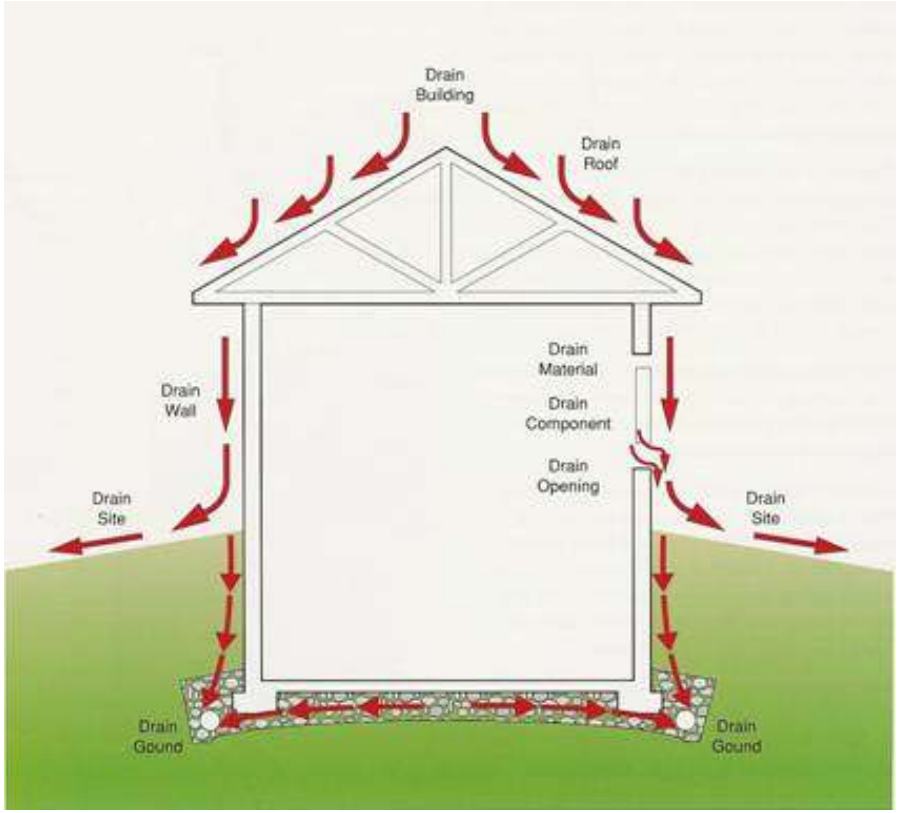


Illustration from the EEBA Water Management Guide, 2002

Rain Exposure

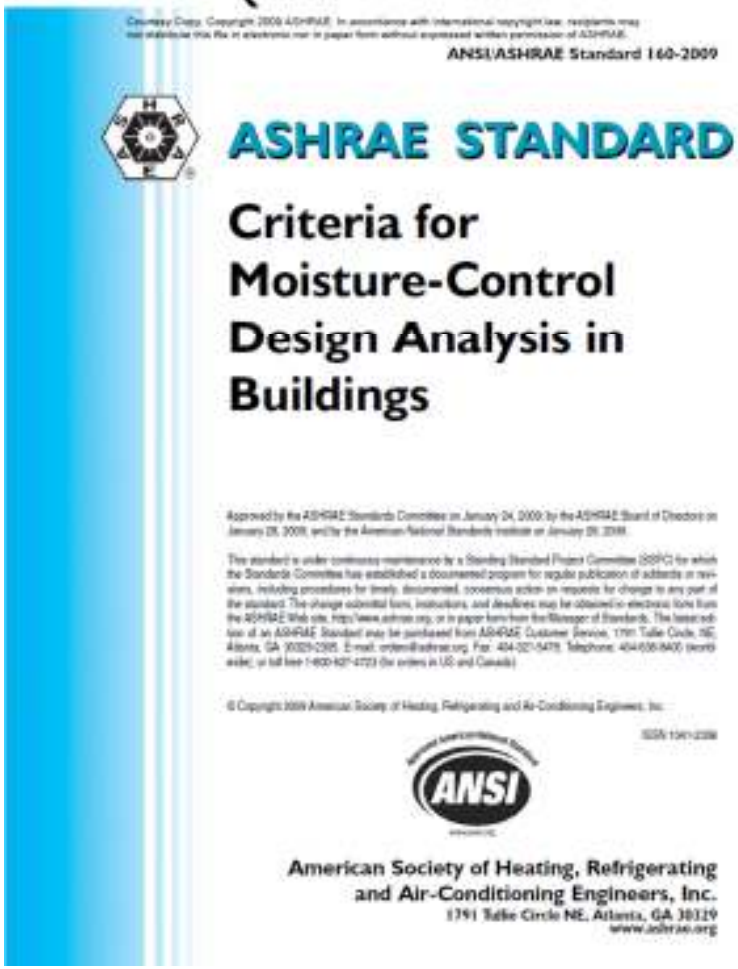


TABLE 4.6.1 Exposure Factor

Building Height, m (ft)	Type of Terrain		
	Severe	Medium	Sheltered
<10 (<33)	1.3	1.0	0.7
10–15 (33–49)	1.3	1.1	0.8
15–20 (49–66)	1.4	1.2	0.9
20–30 (66–98)	1.5	1.3	1.1
30–40 (98–131)	1.5	1.4	1.2
40–50 (131–164)	1.5	1.5	1.3
>50 (>164)	1.5	1.5	1.5

Severe exposure includes hilltops, coastal areas, and funneled wind. Sheltered exposure includes shelter from trees, nearby buildings, or a valley.

The following deposition factors shall be used:

a. Walls below a steep-slope roof: $F_D = 0.35$
b. Walls below a low-slope roof: $F_D = 0.5$
c. Walls subject to rain runoff: $F_D = 1.0^{B\text{-}18}$

"Weather Protection" Code Provisions

1403.2 Weather protection. Exterior walls shall provide the building with a weather-resistant *exterior wall envelope*. The *exterior wall envelope* shall include flashing, as described in Section 1405.4. The *exterior wall envelope* shall be designed and constructed in such a manner as to prevent the accumulation of water within the wall assembly by providing a *water-resistive barrier* behind the exterior veneer, as described in Section 1404.2, and a means for draining water that enters the assembly to the exterior. Protection against condensation in the *exterior wall* assembly shall be provided in accordance with Section 1405.3.

R703.1 General. Exterior walls shall provide the building with a weather-resistant exterior wall envelope. The exterior wall envelope shall include flashing as described in Section R703.4.

…

R703.1.1 Water resistance. The exterior wall envelope shall be designed and constructed in a manner that prevents the accumulation of water within the wall assembly by providing a water-resistant barrier behind the exterior veneer as required by Section R703.2 and a means of draining to the exterior water that enters the assembly. Protection against condensation in the exterior wall assembly shall be provided in accordance with Section R702.7 of this code.

- Water-resistive barrier
- Means of draining water
- Flashing
- Protection against condensation

Water-Resistive Barrier Code Provisions

1404.2 Water-resistive barrier. A minimum of one layer of No.15 asphalt felt, complying with ASTM D 226 for Type 1 felt or other *approved* materials, shall be attached to the studs or sheathing, with flashing as described in Section 1405.4, in such a manner as to provide a continuous *water-resistive barrier* behind the *exterior wall* veneer.

R703.2 Water-resistive barrier. One layer of No. 15 asphalt felt, free from holes and breaks, complying with ASTM D226 for Type 1 felt or other approved water-resistive barrier shall be applied over studs or sheathing of all exterior walls. Such felt or material shall be applied horizontally, with the upper layer lapped over the lower layer not less than 2 inches (51 mm). Where joints occur, felt shall be lapped not less than 6 inches (152 mm). The felt or other approved material shall be continuous to the top of walls and terminated at penetrations and building appendages in a manner to meet the requirements of the exterior wall envelope as described in Section R703.1. The water-resistive barrier is not required for detached accessory buildings.

Performance = Material + Installation

Flashing Code Provisions

1405.4 Flashing. Flashing shall be installed in such a manner so as to prevent moisture from entering the wall or to redirect it to the exterior. Flashing shall be installed at the perimeters of exterior door and window assemblies, penetrations and terminations of *exterior wall* assemblies, *exterior wall* intersections with roofs, chimneys, porches, decks, balconies and similar projections and at built-in gutters and similar locations where moisture could enter the wall. Flashing with projecting flanges shall be installed on both sides and the ends of copings, under sills and continuously above projecting *trim*.

R703.4 Flashing. Approved corrosion-resistant flashing shall be applied shingle-fashion in a manner to prevent entry of water into the wall cavity or penetration of water to the building structural framing components. Self-adhered membranes used as flashing shall comply with AAMA 711. Fluid-applied membranes used as flashing in exterior walls shall comply with AAMA 714. The flashing shall extend to the surface of the exterior wall finish. Approved corrosion-resistant flashings shall be installed at the following locations:

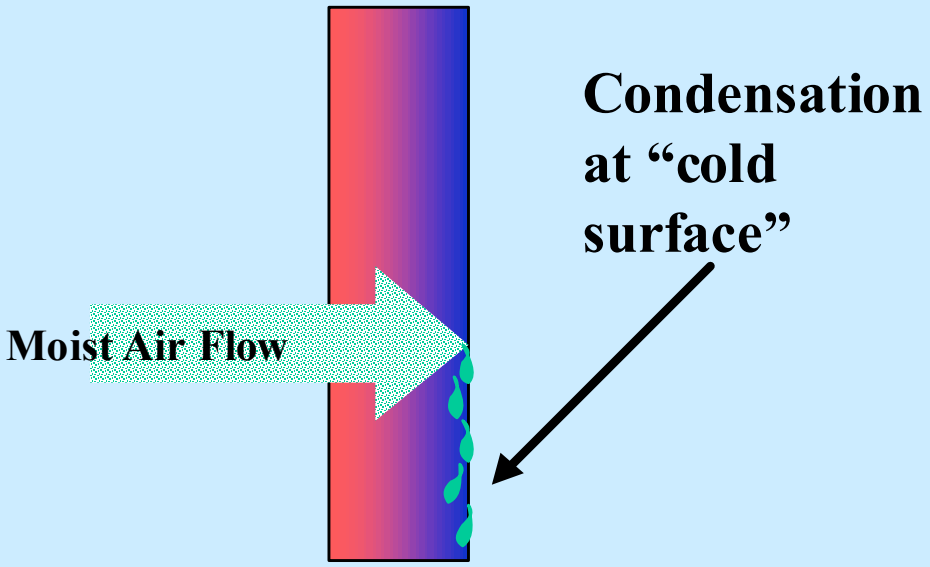
1. Exterior window and door openings. Flashing at exterior window and door openings shall extend to the surface of the exterior wall finish or to the water-resistive barrier complying with Section 703.2 for subsequent drainage. Mechanically attached flexible flashings shall comply with AAMA 712. Flashing at exterior window and door openings shall be installed in accordance with one or more of the following:

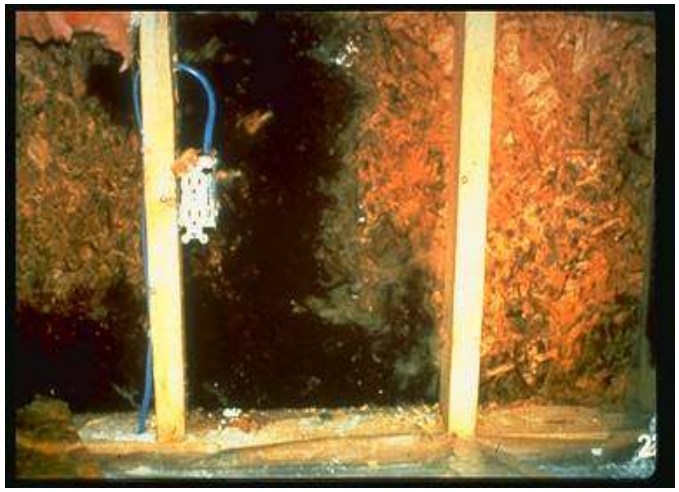
1.1. The fenestration manufacturer's installation and flashing instructions, or for applications not addressed in the fenestration manufacturer's instructions, in accordance with the flashing manufacturer's instructions. Where flashing instructions or details are not provided, pan flashing shall be installed at the sill of exterior window and door openings. Pan flashing shall be sealed or sloped in such a manner as to direct water to the of the exterior wall finish or to the water-resistive barrier for subsequent drainage. Openings using pan flashing shall incorporate flashing or protection at the head and sides.

1.2. In accordance with the flashing design or method of a registered design professional.

1.3. In accordance with other approved methods.

Condensation Control and Drying Potential





How are vapor retarders defined?

Different Classes of Vapor Retarders

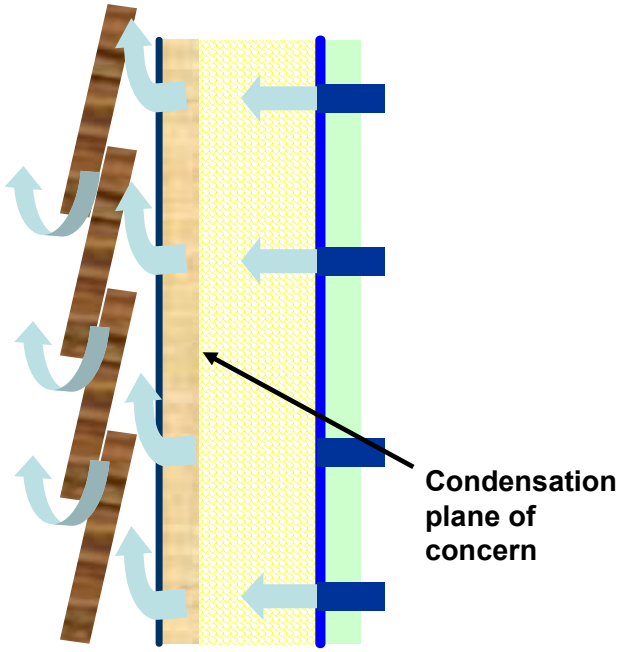
- Class I: 0.1 perm or less
  - Sheet polyethylene, non-perforated aluminum foil
- Class II: 0.1 < perm ≤ 1.0 perm
  - Kraft faced fiberglass batts or low perm paint
  - (paint with 0.1 < perm ≤ 1.0)
- Class III: 1.0 < perm ≤ 10 perm
  - Latex or enamel paint

Vapor Retarder Requirements – Interior side of frame walls

Climate Zone	IBC - Requirement	Exceptions	IRC - Requirement	Exceptions
1 & 2	Class I or II vapor retarders shall not be provided			
3	Class I vapor retarders shall not be provided			
4 x-marine	Class I vapor retarders shall not be provided			
4 marine	Class II vapor retarders shall be provided	Class III vapor retarders can be used with vented cladding or specific R-values of exterior insulation. Only Class III vapor retarders shall be used with exterior foam plastic insulating sheathing with perm rating of less than 1 perm	Class I or II vapor retarders are required	Class III vapor retarders can be used with vented cladding or specific R-values of exterior insulation.
5 to 8	Class I or II vapor retarders shall be provided	Class III vapor retarders can be used with vented cladding or specific R-values of exterior insulation Only Class III vapor retarders shall be used with exterior foam plastic insulating sheathing with perm rating of less than 1 perm	Class I or II vapor retarders are required	Class III vapor retarders can be used with vented cladding or specific R-values of exterior insulation.

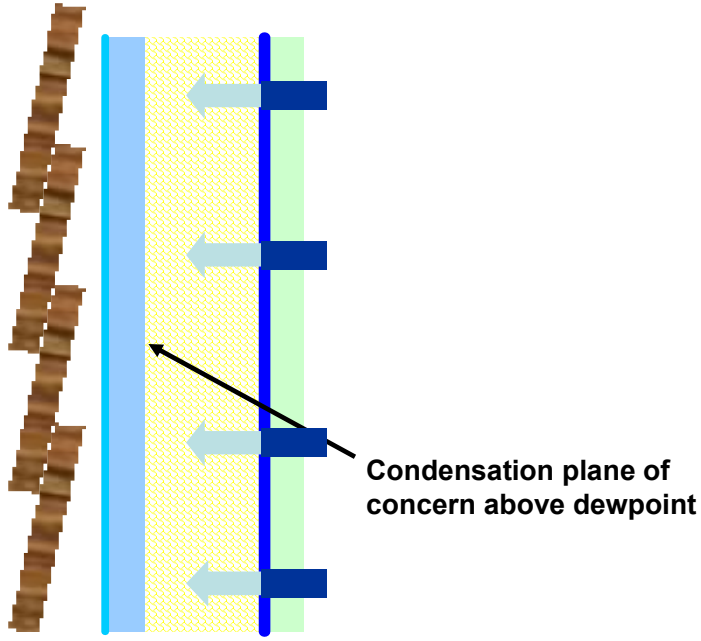
Since 2009 – Class III Vapor Retarders allowed in cold climates

VENTILATED CLADDING



Includes vinyl and brick with airspace

EXTERIOR INSULATION



Specific sheathing R-Values dependent on climate.

I-codes 2015:
Condensation Protection Requirements

R702.7.3 Minimum clear air spaces and vented openings for vented cladding. For the purposes of this section, vented cladding shall include the following minimum clear air spaces. Other openings with the equivalent vent area shall be permitted.

1. Vinyl lap or horizontal aluminum siding applied over a weather resistive barrier as specified in Table R703.4.
2. Brick veneer with a clear airspace as specified in Table R703.7.4.
3. Other approved vented claddings.

TABLE R702.7.1
CLASS III VAPOR RETARDERS

CLIMATE ZONE	CLASS III VAPOR RETARDERS PERMITTED FOR:[a]
Marine 4	Vented cladding over wood structural panels. Vented cladding over fiberboard. Vented cladding over gypsum. Insulated sheathing with *R*-value ≥ 2.5 over 2 × 4 wall. Insulated sheathing with *R*-value ≥ 3.75 over 2 × 6 wall.
5	Vented cladding over wood structural panels. Vented cladding over fiberboard. Vented cladding over gypsum. Insulated sheathing with *R*-value ≥ 5 over 2 × 4 wall. Insulated sheathing with *R*-value ≥ 7.5 over 2 × 6 wall.
6	Vented cladding over fiberboard. Vented cladding over gypsum. Insulated sheathing with *R*-value ≥ 7.5 over 2 × 4 wall. Insulated sheathing with *R*-value ≥ 11.25 over 2 × 6 wall.
7 and 8	Insulated sheathing with *R*-value ≥ 10 over 2 × 4 wall. Insulated sheathing with *R*-value ≥ 15 over 2 × 6 wall.

Summary

- Multi-family construction code requirements are dependent on height and construction materials.
- NFPA 285 is required for non-Type V construction as height on buildings increases. Testing is triggered by specific materials
- Water management code requirements are less prescriptive for those buildings under the Residential Code.
- Multifamily construction has more and more varied water-management details.
- Vapor retarder requirements are evolving differently between IBC and IRC. The IBC-2015 now puts limits on interior wall vapor retarders.

Thank you for your attention.
Please ask any questions.

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