Selected Topics in Residential Construction

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Description

The challenges facing the residential construction industry are widespread as new technologies, materials, and construction techniques continue to gain prominence. This session will dive into three different areas that continue to be a source of attention for industry professionals, including the PA Alternative Residential Energy Provisions, adhered masonry veneer assemblies, and mechanical ventilation. Each of these topics addresses different areas of the construction process and require some discussion of code enforcement, design strategies, and material selection.

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Learning Objectives

1. Provide an overview of the residential construction industry and the challenges faced by builders, design professionals, and code officials.
2. Discuss available energy code compliance paths and the impact on energy consumption in the home while focusing specifically on the PA Alternative.
3. Revisit the adhered masonry veneer assembly options that were impacted by recent requirements to include a rainscreen in the assembly.
4. Examine the role of mechanical ventilation in the performance of the home while reviewing code-compliant options in the Uniform Construction Code.

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PA Alternative Residential Energy Provisions Update

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Description

- The Pennsylvania Uniform Construction Code (UCC) Review and Advisory Council (RAC) completed the review of the 2018 I-Codes on April 29, 2021. The code provisions that were adopted during this process will take effect in the first quarter of 2022. These changes trigger an update of the PA Alternative Residential Energy Provisions. The Pennsylvania Alternative Residential Energy Provisions were developed with the intent of being: simpler to build and easier to enforce; more rational and flexible; focused on Pennsylvania in terms of climatic and other conditions; and, equivalent to the provisions of the International Energy Conservation Code (IECC) in terms of energy efficiency. This session will dig into the updated version of this standard.

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Learning Objectives

1. Discuss the overall intent of the PA Alternative Residential Energy Provisions as an energy code compliance path, including flexibility and simplicity.
2. Evaluate the available energy enhancement options that can be used as entrance requirements for this compliance path, including upgrades to building enclosure elements, higher efficiency equipment, and renewable energy generation.
3. Identify available trade-offs that are provided due to the inclusion of an energy enhancement option, such as alternative building enclosure parameters, and their effect on building performance.
4. Identify the impact of electing to use this compliance path on the permit and inspection process.

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UCC Energy Code Summary

Chapter 11 | Residential Provisions

7

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IECC Compliance Options

Prescriptive	Total UA Alternative	Simulated Performance Alternative	ERI Path
Sections R402.1 through R402.3, R403.3.1, R403.3.4, and R403.5.3 Indicated as **(Prescriptive)**	**Section R402.1.4** Calculate manually RES*check* Other software	**Section R405** RES*check* Other software	**Section R406** HERS Index

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PA Alternative Residential Energy Provisions

- Based on the 2018 IECC and UCC Amendments
- Compliance allowed by UCC Title 34, Chapter 403
- Created and published by the Pennsylvania Housing Research Center
- Allows trade-offs

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Overview of Energy Code Changes

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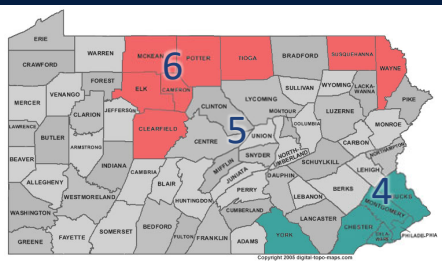
Climate Zones in PA



Copyright 2005 digital-topo-maps.com

Image Source: digital-topo-maps.com

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2015 IRC Table N1102.1.2

Table N1102.1.2 (R402.1.2)
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT [a]

Climate Zone	Fenestration *U*-Factor	SKYLIGHT[b] *U*-FACTOR	GLAZED FENESTRATION SHGC[b, e]	CEILING *R*-VALUE	WOOD FRAME WALL *R*-VALUE[f]	MASS WALL *R*-VALUE	FLOOR *R*-VALUE	BAWSEMENT[c] WALL *R*-VALUE	SLAB[d] *R*-VALUE & DEPTH	CRAWL SPACE[c] WALL *R*-VALUE
1	NR	0.75	0.25	30	13	3/4	13	0	0	0
2	0.40	0.65	0.25	38	13	4/6	13	0	0	0
3	0.35	0.55	0.25	38	20 or 13 + 5[h]	8/13	19	5/13[f]	0	5/13
4 except Marine	0.35	0.55	0.40	49	20 or 13 + 5[h]	8/13	19	10/13	10, 2 ft	10/13
5 and Marine 4	0.32	0.55	NR	49	20 or 13 + 5[h]	13/17	30[g]	15/19	10, 2 ft	15/19
6	0.32	0.55	NR	49	20 + 5 or 13 + 10[h] or 18 + 6.5[h]	15/20	30[g]	15/19	10, 4 ft	15/19
7 and 8	0.32	0.55	NR	49	20 + 5 or 13 + 10[h]	19/21	38[g]	15/19	10, 4 ft	15/19

Source: International Code Council (ICC). (2014). 2015 International Residential Code, Country Club Hill, Ill.

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2018 IRC Table N1102.1.2

Table N1102.1.2 (R402.1.2)
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT [a]

Climate Zone	Fenestration *U*-Factor	SKYLIGHT[b] *U*-FACTOR	GLAZED FENESTRATION SHGC[b, e]	CEILING *R*-VALUE	WOOD FRAME WALL *R*-VALUE[i]	MASS WALL *R*-VALUE	FLOOR *R*-VALUE	BAWSEMENT[c] WALL *R*-VALUE	SLAB[d] *R*-VALUE & DEPTH	CRAWL SPACE[c] WALL *R*-VALUE
1	NR	0.75	0.25	30	13	3/4	13	0	0	0
2	0.40	0.65	0.25	38	13	4/6	13	0	0	0
3	0.35	0.55	0.25	38	20 or 13 + 5[h]	8/13	19	5/13[f]	0	5/13
4 except Marine	0.32	0.55	0.40	49	20 or 13 + 5[h]	8/13	19	10/13	10, 2 ft	10/13
5 and Marine 4	0.30	0.55	NR	49	20 or 13 + 5[h]	13/17	30[g]	15/19	10, 2 ft	15/19
6	0.30	0.55	NR	49	20 + 5[h] or 13 + 10[h]	15/20	30[g]	15/19	10, 4 ft	15/19
7 and 8	0.30	0.55	NR	49	20 + 5[h] or 13 + 10[h]	19/21	38[g]	15/19	10, 4 ft	15/19

Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, Ill.

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2018 IRC N1102.4.1.2 (R402.4.1.2) Testing

- The building or dwelling unit shall be tested and verified as having an air leakage rate of 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 RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pascals).

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2021 PA Alternative Residential Energy Provisions

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PA UCC Section 301(c)

- (c) Prescriptive methods for energy-related standards.– The department shall, within 180 days of the effective date of this section, by regulation promulgate prescriptive methods to implement the energy-related standards of the Uniform Construction Code which take into account the various climatic conditions through this Commonwealth. In deriving these standards the department shall seek to balance energy savings with initial construction costs.

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12 Pa. Code §145.42. Alternate standards.

(Chapter 145 – Industrial Housing and Components)

- (1) As an alternate to the ICC International Residential Code, Chapter 11, regarding energy efficiency, the manufacturer may use the applicable edition of one of the following:
  - (i) The prescriptive methods for residential buildings in the International Energy Conservation Code compliance guide containing state maps, prescriptive energy packages and related software published by the United States Department of Energy, Building Standards and Guidelines Program (REScheckTM).
  - (ii) Pennsylvania's Alternative Residential Energy Provisions developed by the Pennsylvania Housing Research Center at the Pennsylvania State University.

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Source: http://www.pacodeandbulletin.gov/Display/pacode?file=/secure/pacode/data/012/chapter145/s145.42.html&d=reduce

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Scope Clarification

SECTION PA100

GENERAL

PA101 Scope. The provisions of this document regulate energy efficiency for the design and construction of buildings regulated by the 2018 International Residential Code (IRC) as incorporated in the PA Uniform Construction Code (UCC) in the Commonwealth of Pennsylvania. In addition, the provisions of this document only apply to new construction of 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 not more than three stories above grade plane in height and are not applicable to alteration, repair, addition, and change of occupancy of existing buildings and structures.

Exception: Portions of the building envelope that do not enclose conditioned space.

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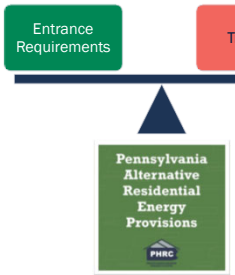
PA Alternative Residential Energy Provisions



- Choose one (1) Entrance Requirement
  - "Energy Enhancement Options"
- Receive ALL tradeoffs
- Energy modeling completed (BEopt) to ensure equivalent energy usage

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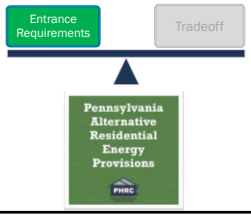
Energy Enhancement Options

Choose ONE of the following Energy Enhancement Options to qualify for the alternative path.



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Energy Enhancement Options

Table PA104
Energy Enhancement Options

Option	Description		Minimum efficiency by climate zone		
			South (4)	Central (5)	North (6)
1	Ductless heat pumps		8.5 HSPF and 15 SEER	10 HSPF and 15 SEER	10 HSPF and 15 SEER
2	All air ducts located inside the thermal envelope		Compliant	Compliant	Compliant
3	Geothermal or water source heat pump installed		Compliant	Compliant	Compliant
4	Improved efficiency air source heat pump installed		9.5 HSPF and 19 SEER	9.5 HSPF and 19 SEER	11 HSPF and 19 SEER
5	Improved efficiency condensing furnace installed		92 AFUE	95 AFUE	95 AFUE
6	Exterior continuous insulation		R20+10	R20+10	R20+15
7	Improved efficiency windows		U-factor = 0.25	U-factor = 0.19	U-factor = 0.15
8	Package: Improved efficiency windows and higher attic R-value with raised heel truss[a]	Windows	U-factor = 0.25	U-factor = 0.21	U-factor = 0.19
		Attic	R-value = 60	R-value = 60	R-value = 60
9	Package: Improved efficiency windows and heat pump water heater	Windows	U-factor = 0.25	U-factor = 0.21	U-factor = 0.19
		Heat Pump Water Heater	Compliant	Compliant	Compliant

Notes:
a. Full height of uncompressed insulation shall extend over the top plate at the eaves.
b. For multiple cooling systems, all systems shall meet or exceed the minimum efficiency requirements in this section and shall be sized to serve 100 percent of the cooling design load. For multiple heating systems, all systems shall meet or exceed the minimum efficiency requirements in this section and shall be sized to serve 100 percent of the heating design load.

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Energy Enhancement Options

1. Ductless heat pumps

Minimum efficiency by climate zone		
South (4)	Central (5)	North (6)
8.5 HSPF *and* 15 SEER	10 HSPF *and* 15 SEER	10 HSPF *and* 15 SEER

Notes:
a. Full height of uncompressed insulation shall extend over the top plate at the eaves.
b. For multiple cooling systems, all systems shall meet or exceed the minimum efficiency requirements in this section and shall be sized to serve 100 percent of the cooling design load. For multiple heating systems, all systems shall meet or exceed the minimum efficiency requirements in this section and shall be sized to serve 100 percent of the heating design load.

Image Source: http://synergy-green-builders.com/tag/mini-split-pumps/

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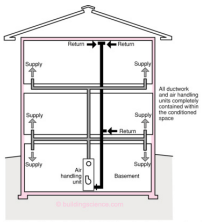
Energy Enhancement Options

2. All air ducts located inside the thermal envelope



Note: Colored shading depicts the building's thermal barrier and pressure boundary. The thermal barrier and pressure boundary enclose the conditioned space.

Minimum efficiency by climate zone		
South (4)	Central (5)	North (6)
Compliant	Compliant	Compliant

Notes:
a. Full height of uncompressed insulation shall extend over the top plate at the eaves.
b. For multiple cooling systems, all systems shall meet or exceed the minimum efficiency requirements in this section and shall be sized to serve 100 percent of the cooling design load. For multiple heating systems, all systems shall meet or exceed the minimum efficiency requirements in this section and shall be sized to serve 100 percent of the heating design load.

Image Source: https://buildingscience.com/documents/information-sheets/information-sheet-ducts-in-conditioned-space

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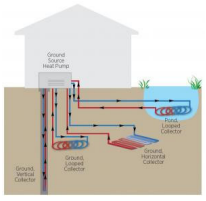
Energy Enhancement Options

3. Geothermal or water source heat pump installed



Minimum efficiency by climate zone		
South (4)	Central (5)	North (6)
Compliant	Compliant	Compliant

Notes:
a. Full height of uncompressed insulation shall extend over the top plate at the eaves.
b. For multiple cooling systems, all systems shall meet or exceed the minimum efficiency requirements in this section and shall be sized to serve 100 percent of the cooling design load. For multiple heating systems, all systems shall meet or exceed the minimum efficiency requirements in this section and shall be sized to serve 100 percent of the heating design load.

Image Source: https://basc.pnnl.gov/resource-guides/geothermal-heat-pumps

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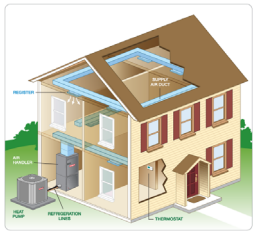
Energy Enhancement Options

4. Improved efficiency air source heat pump installed



Minimum efficiency by climate zone		
South (4)	Central (5)	North (6)
9.5 HSPF *and* 19 SEER	9.5 HSPF *and* 19 SEER	11 HSPF *and* 19 SEER

Notes:
a. Full height of uncompressed insulation shall extend over the top plate at the eaves.
b. For multiple cooling systems, all systems shall meet or exceed the minimum efficiency requirements in this section and shall be sized to serve 100 percent of the cooling design load. For multiple heating systems, all systems shall meet or exceed the minimum efficiency requirements in this section and shall be sized to serve 100 percent of the heating design load.

Image Source: https://www.goodmanmfg.com/resources/heating-cooling-101/how-a-heat-pump-works

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Energy Enhancement Options

5. Improved efficiency condensing furnace installed

Minimum efficiency by climate zone		
South (4)	Central (5)	North (6)
92 AFUE	95 AFUE	95 AFUE

Notes:
a. Full height of uncompressed insulation shall extend over the top plate at the eaves.
b. For multiple cooling systems, all systems shall meet or exceed the minimum efficiency requirements in this section and shall be sized to serve 100 percent of the cooling design load. For multiple heating systems, all systems shall meet or exceed the minimum efficiency requirements in this section and shall be sized to serve 100 percent of the heating design load.

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Energy Enhancement Options

6. Exterior continuous insulation

Minimum efficiency by climate zone		
South (4)	Central (5)	North (6)
R20+10	R20+10	R20+15

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Energy Enhancement Options

7. Improved efficiency windows

Minimum efficiency by climate zone		
South (4)	Central (5)	North (6)
U-factor = 0.21	U-factor = 0.19	U-factor = 0.15

Image Source: http://peoriasiding.com/tag/best-replacement-windows-in-illinois/

28

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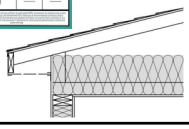
Energy Enhancement Options

8. Package: Improved efficiency windows & higher attic R-value with raised heel truss



	Minimum efficiency by climate zone		
	South (4)	Central (5)	North (6)
Windows	U-factor = 0.25	U-factor = 0.21	U-factor = 0.19
Attic	R-value = 60	R-value = 60	R-value = 60

Notes:
a. Full height of uncompressed insulation shall extend over the top plate at the eaves.

Image Source: TOP - http://peoriasiding.com/tag/best-replacement-windows-in-illinois/
BOTTOM – 2018 PA Alternative Energy Provisions

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Energy Enhancement Options

9. Package: Improved efficiency windows & heat pump water heater

	Minimum efficiency by climate zone		
	South (4)	Central (5)	North (6)
Windows	U-factor = 0.25	U-factor = 0.21	U-factor = 0.19
Heat Pump Water Heater	Compliant	Compliant	Compliant

Image Source: LEFT - http://peoriasiding.com/tag/best-replacement-windows-in-illinois/
RIGHT – http://westinghousewaterheating.com/electric-heat-pump-water-heater.html

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Energy Tradeoffs

- ALL of the following are allowed as a reduction when at least one energy enhancement option has been met.

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Climate Zones in PA

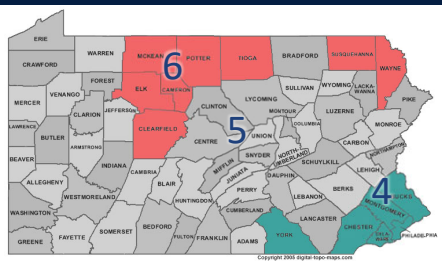

Image Source: digital-topo-maps.com

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2018 IRC Section N1102.2.2

- Ceilings without attic spaces
  - Where Section N1102.1.2 requires insulation R-values greater than R-30 in the ceiling and the design of the roof/ceiling assembly does not allow sufficient space for the required insulation, the minimum required insulation R-value for such roof/ceiling assemblies shall be R-30. Insulation shall extend over the top of the wall plate to the outer edge of such plate and shall not be compressed.
  - This reduction of insulation from the requirements of Section N1102.1.2 shall be limited to 500 square feet (46 m2) or 20 percent of the total insulated ceiling area, whichever is less.

Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, Ill.

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Energy Tradeoffs

1. Cathedral ceilings: R-30 insulation, for up to 75% of the total *living space* square footage area

PA302.2 Ceilings without attic spaces. Where the design of the roof/ceiling assembly does not allow sufficient space for the required insulation, such as cathedral ceilings, the minimum required insulation for such roof/ceiling assemblies shall be R-30. Insulation shall extend over the top of the wall plate to the outer edge of such plate and shall not be compressed. This reduction of insulation from the requirements of Section PA301 shall be limited to 75% of the total *living space* square footage area.

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2018 IRC Section N1102.2.4

- Access hatches and doors
  - Access doors from conditioned spaces to unconditioned spaces such as attics and crawl spaces shall be weatherstripped and insulated to a level equivalent to the insulation on the surrounding surfaces.

35

Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, Ill.

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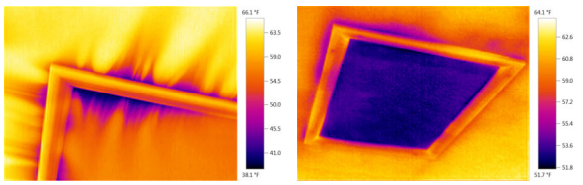
Attic Access Gone Wrong



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Energy Tradeoffs

2. Attic Hatches: R-20 instead of full insulation req't

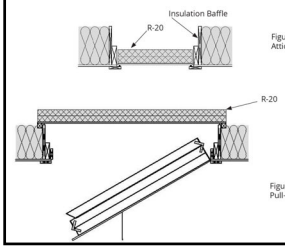

Figure PA302.3 (1)
Attic Hatch

Figure PA302.3 (2)
Pull-Down Stairs

PA302.4 Access hatches and doors. Access hatches and doors from conditioned spaces to unconditioned spaces (e.g., attics and crawl spaces) shall be weather stripped. Both vertical and horizontal access hatches shall be insulated to a minimum of R-20 with rigid foam permanently attached to the access hatch. This is not intended to restrict the use of proprietary products meeting the intent of this provision. Side hinged access door shall meet the fenestration requirements of Table PA301.

A wood framed or equivalent baffle or retainer is required to be provided when loose fill insulation is installed. The purpose of which is to prevent the loose fill insulation from spilling into the living space when the attic access is opened. Areas around access hatches required to service equipment shall provide a permanent means of maintaining the installed R-value of the insulation.

Exception: Vertical doors that provide access from conditioned to unconditioned spaces shall be permitted to meet the fenestration requirements of Table PA301 based on the applicable climate zone specified in section PA201.1.

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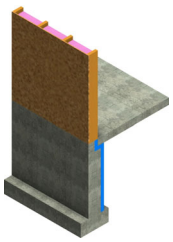
2018 IRC Section N1102.2.10

- **Slab-on-grade floors**
  - The insulation shall extend downward from the top of the slab on the outside or inside of the foundation wall



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Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, Ill.

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Energy Tradeoffs

3. Slab edge insulation: Thermal break

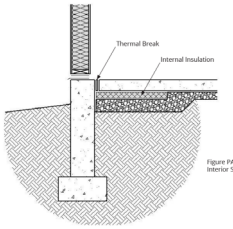

Figure PA302.7.2
Interior Slab Insulation

PA302.9.2 Interior Insulation. Interior insulation shall be installed from the bottom of the slab and extend the distance provided in Table PA301 by any combination of vertical insulation or horizontal insulation extending under the slab. The slab edge shall be separated from the foundation wall by a continuous ½ inch thermal break as per Figure PA302.8.(2) A thermal break shall be created by a material suitable for ground contact, which includes, but is not limited to, asphalt impregnated fiber board or extruded polystyrene. Slab-edge insulation is not required in jurisdictions designated by the code official as having a very heavy termite infestation.

Note: The provisions in PA302.9.2 only apply to unheated slabs. For heated slabs, refer to requirements in 2018 IRC Table N1102.1.2 (R402.1.2) and 2018 IRC Section N1102.2.10 (R402.2.10).

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2018 IRC Section N1102.3.4

- **Opaque door exemption**
  - One side-hinged opaque door assembly not greater than 24 square feet (2.22 m2) in area shall be exempt from the U-factor requirement in Section N1102.1.2.

Source: International Code Council (ICC), (2017). 2018 International Residential Code, Country Club Hill, Ill.

Energy Tradeoffs

4. Opaque doors: 54ft² U-factor exemption (instead of 24ft²)

PA303.4 Opaque door exemption. One door assembly, including side hinged opaque doors, sidelights and transoms, up to 54 square feet (5.02 m²) in area is exempted from the U-factor requirement in Table PA301.

Image Source: http://openl.co/prehung-exterior-french-doors/exterior-french-doors-interior-rustic-wood-prehung-installing-with/

N1101.6, Tables N1101.10.3(1) & N1101.10.3(2) – Fenestration Definitions and U-Factors

- **Change Type:** Hqfwkhfyts
- **Change Summary:** Ymj ijkxsnyts x k:wxp-qlmyx fsi {jwnhfqkjsjxywfyts mf{j gjjs r t{ji zsijwymj ijkxsnyts k:wkjsjxywfyts1fsi f ijkxsnyts k:wtufvzj ittwmfx gjjs fiiji3
- KJS JXYWFYNTS 3Uwtizhyx hqfxxknji fx jnmjw{jwnhfqkjsjxywfyts twxp-qlmyx3
  - Xp-qlmyx3Lqfxx twtymjwywfsxxufwjsytwywfsxxqhjsylqf;ml r fyjwfqnxxfqgji fyf xqjuj tkqjxx ymfs ;5 ijlwjjx -63: wfi. kwtr mtwitsyfqj
  - [jwnhfqKjsjxywfyts3\ mit| xymfyfwj knji twtujwfqgjltufvzj ittwcllqfjji ittwcllqfjji gqjhp fsi htr gnnfyts tufvzjdlqfjji ittwkhtr utxji tklqfxx twtymjwywfsxxufwjsytwywfsxxqhjsylqf;ml r fyjwfqx fsi nxxfqgji fyf xqjuj tk styqjxx ymfs ;5 ijlwjjx -63: wfi.kwtr mtwitsyfqj
- TUFVZJ ITTW3F ittwymfynx styqjxx ymfs :5 ujwhjsytufvzj ns xzwkfhj fwjf3

Source: International Code Council (ICC), (2018). 2018 Significant Changes to the International Residential Code, Country Club Hill, Ill.

2018 IRC Table N1102.1.2

Table N1102.1.2 (R402.1.2)
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT [a]

Climate Zone	Fenestration *U*-Factor	SKYLIGHT[b] *U*-FACTOR	GLAZED FENESTRATION SHGC[b, e]	CEILING *R*-VALUE	WOOD FRAME WALL *R*-VALUE[i]	MASS WALL *R*-VALUE	FLOOR *R*-VALUE	BAWSEMENT[c] WALL *R*-VALUE	SLAB[d] *R*-VALUE & DEPTH	CRAWL SPACE[c] WALL *R*-VALUE
1	NR	0.75	0.25	30	13	3/4	13	0	0	0
2	0.40	0.65	0.25	38	13	4/6	13	0	0	0
3	0.35	0.55	0.25	38	20 or 13 + 5[h]	8/13	19	5/13[f]	0	5/13
4 except Marine	0.32	0.55	0.40	49	20 or 13 + 5[h]	8/13	19	10/13	10, 2 ft	10/13
5 and Marine 4	0.30	0.55	NR	49	20 or 13 + 5[h]	13/17	30[g]	15/19	10, 2 ft	15/19
6	0.30	0.55	NR	49	20 + 5[h] or 13 + 10[h]	15/20	30[g]	15/19	10, 4 ft	15/19
7 and 8	0.30	0.55	NR	49	20 + 5[h] or 13 + 10[h]	19/21	38[g]	15/19	10, 4 ft	15/19

Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, Ill.

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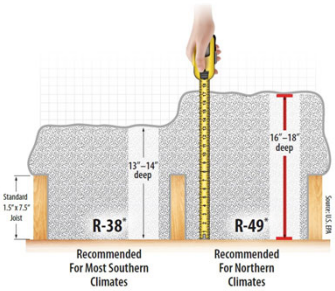
Attic Insulation

- How much thicker?



* Recommended Dept. of Energy attic insulation levels for commonly used fiberglass, mineral wool, and cellulose insulation assuming about R-3 per inch.

44

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Energy Tradeoffs

5. CZ4 Attic Insulation: R-38 insulation (instead of R-49)

Table PA301
Insulation and Fenestration Requirements by Component[a]

Climate Zone	Fenestration[b] U-factor	Skylights[b] U-factor	Glazed Fenestration SHGC[b,e]	Ceiling R-value	Wood Frame Wall R-value	Mass Wall R-value[h]	Floor R-value	Basement[c] Wall R-value	Slab[d] R-value and depth	Crawlspace[c] Wall R-value
South (4)	0.32	0.55	0.4	38	20[h] or 13+5[g]	8/13	19	10/13	10, 2 ft	10/13
Central (5)	0.30	0.55	NR	49	20[h] or 13+5[g]	13/17	30[f]	10/13	10, 2 ft	10/13
North (6)	0.30	0.55	NR	49	23, 20+5[g], , or 13+10[g]	15/20	30[f]	10/13	10, 4 ft	10/13

Image Source: 2021 PA Alternative Energy Provisions

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2018 IRC Table N1102.1.2

Table N1102.1.2 (R402.1.2)
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT [a]

Climate Zone	Fenestration *U*-Factor	SKYLIGHT[b] *U*-FACTOR	GLAZED FENESTRATION SHGC[b, e]	CEILING *R*-VALUE	WOOD FRAME WALL *R*-VALUE[i]	MASS WALL *R*-VALUE	FLOOR *R*-VALUE	BAWSEMENT[c] WALL *R*-VALUE	SLAB[d] *R*-VALUE & DEPTH	CRAWL SPACE[c] WALL *R*-VALUE
1	NR	0.75	0.25	30	13	3/4	13	0	0	0
2	0.40	0.65	0.25	38	13	4/6	13	0	0	0
3	0.35	0.55	0.25	38	20 or 13 + 5[h]	8/13	19	5/13[f]	0	5/13
4 except Marine	0.32	0.55	0.40	49	20 or 13 + 5[h]	8/13	19	10/13	10, 2 ft	10/13
5 and Marine 4	0.30	0.55	NR	49	20 or 13 + 5[h]	13/17	30[g]	15/19	10, 2 ft	15/19
6	0.30	0.55	NR	49	20 + 5[h] or 13 + 10[h]	15/20	30[g]	15/19	10, 4 ft	15/19
7 and 8	0.30	0.55	NR	49	20 + 5[h] or 13 + 10[h]	19/21	38[g]	15/19	10, 4 ft	15/19

Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, Ill.

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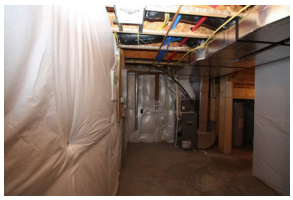
Basement Wall Insulation



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Energy Tradeoffs

6. Basement Walls: R-10 insulation option (instead of R-15)

Table PA301
Insulation and Fenestration Requirements by Component[a]

Climate Zone	Fenestration[b] U-factor	Skylights[b] U-factor	Glazed Fenestration SHGC[b,e]	Ceiling R-value	Wood Frame Wall R-value	Mass Wall R-value[h]	Floor R-value	Basement[c] Wall R-value	Slab[d] R-value and depth	Crawlspace[c] Wall R-value
South (4)	0.32	0.55	0.4	38	20[h] or 13+5[g]	8/13	19	10/13	10, 2 ft	10/13
Central (5)	0.30	0.55	NR	49	20[h] or 13+5[g]	13/17	30[f]	10/13	10, 2 ft	10/13
North (6)	0.30	0.55	NR	49	23, 20+5[g], or 13+10[g]	15/20	30[f]	10/13	10, 4 ft	10/13

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2018 IRC Table N1102.1.2

Table N1102.1.2 (R402.1.2)
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT [a]

Climate Zone	Fenestration *U*-Factor	SKYLIGHT[b] *U*-FACTOR	GLAZED FENESTRATION SHGC[b, e]	CEILING *R*-VALUE	WOOD FRAME WALL *R*-VALUE[i]	MASS WALL *R*-VALUE	FLOOR *R*-VALUE	BAWSEMENT[c] WALL *R*-VALUE	SLAB[d] *R*-VALUE & DEPTH	CRAWL SPACE[c] WALL *R*-VALUE
1	NR	0.75	0.25	30	13	3/4	13	0	0	0
2	0.40	0.65	0.25	38	13	4/6	13	0	0	0
3	0.35	0.55	0.25	38	20 or 13 + 5[h]	8/13	19	5/13[f]	0	5/13
4 except Marine	0.32	0.55	0.40	49	20 or 13 + 5[h]	8/13	19	10/13	10, 2 ft	10/13
5 and Marine 4	0.30	0.55	NR	49	20 or 13 + 5[h]	13/17	30[g]	15/19	10, 2 ft	15/19
6	0.30	0.55	NR	49	20 + 5[h] or 13 + 10[h]	15/20	30[g]	15/19	10, 4 ft	15/19
7 and 8	0.30	0.55	NR	49	20 + 5[h] or 13 + 10[h]	19/21	38[g]	15/19	10, 4 ft	15/19

Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, Ill.

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Energy Tradeoffs

7. CZ6 Walls: Cavity-Only Wall Insulation Option

Table PA301
Insulation and Fenestration Requirements by Component[a]

Climate Zone	Fenestration[b] U-factor	Skylights[b] U-factor	Glazed Fenestration SHGC[b,e]	Ceiling R-value	Wood Frame Wall R-value	Mass Wall R-value[k]	Floor R-value	Basement[c] Wall R-value	Slab[d] R-value and depth	Crawlspace[c] Wall R-value
South (4)	0.32	0.55	0.4	38	20[h] or 13+5[g]	8/13	19	10/13	10, 2 ft	10/13
Central (5)	0.30	0.55	NR	49	20[h] or 13+5[g]	13/17	30[f]	10/13	10, 2 ft	10/13
North (6)	0.30	0.55	NR	49	23 or 20+5[g], or 13+10[g]	15/20	30[f]	10/13	10, 4 ft	10/13

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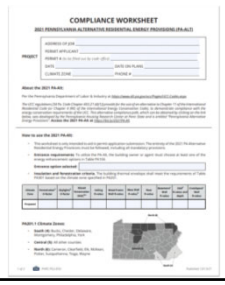
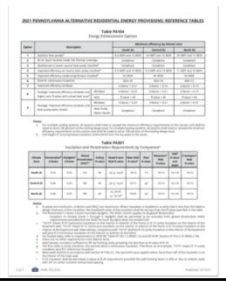
PA Alt Worksheet


COMPLIANCE WORKSHEET
2021 PENNSYLVANIA ALTERNATIVE RESIDENTIAL ENERGY PROVISIONS (PA-ALT)


2021 PENNSYLVANIA ALTERNATIVE RESIDENTIAL ENERGY PROVISIONS: REFERENCE TABLES

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Links

- 2021 PA Alternative Residential Energy Provisions
  - https://bit.ly/2021PA-Alt
- 2021 PA Alternative Worksheet
  - https://bit.ly/2021PA-Alt Worksheet
- Note: we recommend using these links if posting/linking the documents on your own website
  - This will ensure future revisions are automatically linked.

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UCC Energy Code Summary

Chapter 11 + Residential Provisions +

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Questions?

www.phrc.psu.edu

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Adapting Stucco & Stone Assemblies to Changing Codes

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Description

With Pennsylvania's Uniform Construction Code (UCC) updating to the 2018 ICC codes in early 2022, one of the critical changes that building professionals will need to consider involves stucco and stone wall assemblies. During the UCC code adoption process, provisions impacting stucco and stone were adopted based on language out of the 2021 International Residential Code. This session will dive into the changes that will have a significant impact on the design and installation of exterior plaster assemblies.

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Learning Objectives

1. Review the code provisions adopted into the PA Uniform Construction Code that impact stucco and stone wall assemblies.
2. Discuss the impact of new lath installation provisions for exterior plaster assembly including fastener layout and spacing.
3. Examine the implications on building performance of new water-resistive barrier requirements that impact both stucco and stone assemblies.
4. Understand the new requirements for rainscreen gaps in stucco and stone wall assemblies, including associated material options, costs, and performance.

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Definitions

- Exterior Plaster/Stucco
- Adhered Masonry Veneer
- *Rainscreen*
- *Weep Screed*
- *Casing Bead*

**Will be defined throughout today's session*

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What is the Problem?

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Why Have There Been Moisture Failures?

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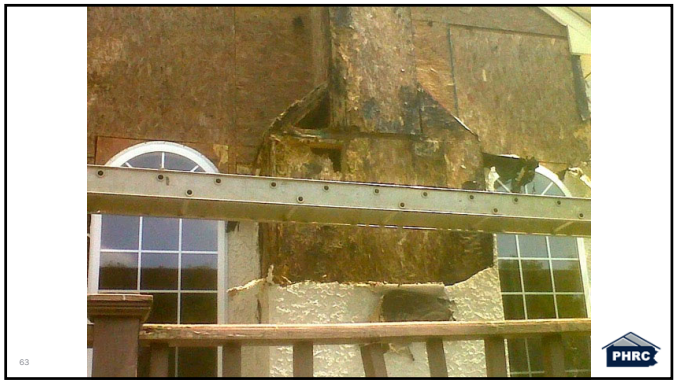

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Enhanced Drying Potential is Now Needed With a Rainscreen Gap

- Allows for Increased Drainage
- Allows a space for air to move. Creating more drying potential, called back ventilation.
- Allows for condensation to occur, and then drain and dry.
- Allows for the cladding and wall system to dry both ways to the rainscreen gap

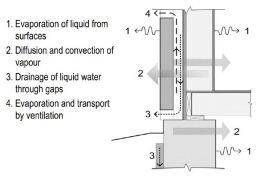

Figure 2: Wall System Drying Mechanisms (Straube & Burnett 2005)

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How are Codes Changing?

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What Changed?

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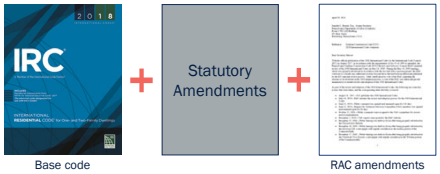
UCC Residential Code Summary



Base code

RAC amendments

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Stucco & Stone in the Codes

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Stucco & Stone Assemblies

- Exterior plaster provisions in the IRC were heavily modified in the 2021 version.
- These provisions were adopted by the UCC RAC to be included with the 2018 code adoption.

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Exterior Plaster: Hardcoat Stucco and Adhered Masonry Veneer

- Stucco will follow the 2021 Exterior plaster section (703.7 Exterior plaster)
  - ASTM C926-2018B
  - ASTM C1063-2018B

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Exterior Plaster: Hardcoat Stucco and Adhered Masonry Veneer

- Adhered masonry veneer will follow the 2018 Section R703.12
- Adhered masonry veneer installation will refer to the 2021 Exterior Plaster section:
  - R703.7.1 which is installation of lath and all accessories
  - R703.7.3 water resistive barriers which will include a rainscreen drainage space

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Key Elements of a Well-Designed Assembly

- Water-resistive barrier(s)
- Rainscreens
- Lath installation
- Weep screeds
- Casing beads

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Water-Resistive Barrier(s)

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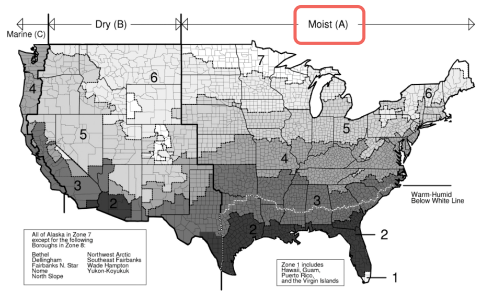

Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, Ill.

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2021 IRC R703.7.3.1 Dry Climates

- **In Dry (B) climate zones indicated in Figure N1101.7, water-resistive barriers shall comply with one of the following:**
  1. The water-resistive barrier shall be **two layers of 10-minute Grade D paper** or have a water resistance equal to or greater than two layers of a water-resistive barrier complying with ASTM E2556-10, Type I. The individual layers shall be installed independently such that each layer provides a separate continuous plane. Flashing installed in accordance with Section R703.4 and intended to drain to the water-resistive barrier shall be directed between the layers.
  2. The water-resistive barrier shall be **60-minute Grade D paper** or have a water resistance equal to or greater than one layer of a water-resistive barrier complying with ASTM E2556-10, Type II. The water-resistive barrier shall be separated from the stucco by a layer of foam plastic insulating sheathing or other non-water-absorbing layer, or a **designed drainage space.**

76 https://www.dll.pa.gov/ucc/Documents/ICC-Code-Review-2018-Final-Report.pdf

76

2021 IRC R703.7.3.2 Moist or Marine Climates

- **In the Moist (A) or Marine (C) climate zones indicated in Figure N1101.7, water-resistive barriers shall comply with one of the following:**
  1. In addition to complying with Section R703.7.3.1, a space or drainage material not less than **3/16 inch** (5 mm) in depth shall be added to the exterior side of the water-resistive barrier.
  2. In addition to complying with Section R703.7.3.1, Item 2, drainage on the exterior of the water-resistive barrier shall have a drainage efficiency of not less than **90 percent**, as measured in accordance with ASTM E2273-2018 or Annex A2 of ASTM E2925-17.

77 https://www.dll.pa.gov/ucc/Documents/ICC-Code-Review-2018-Final-Report.pdf

77

Critical Questions

- **What does 60-minute Grade D paper mean?**
  - What qualifies as a 60-minute Grade D paper?
  - How do we handle proprietary products?
  - What about felt paper?

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Rainscreens

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What is a Rainscreen?

- A rainscreen is a *system* that provides an air space within a wall assembly to promote drainage and drying of that assembly
  - Accelerates the evaporation of undrained moisture behind exterior cladding
  - Helps to dry wall that accumulates moisture seasonally
- Common rainscreen products / systems
  - Furring strips
  - Three-dimensional mesh

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Types of Rainscreen Systems

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Critical Questions

- What are examples of rainscreens?
- What are NOT examples of rainscreens?

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Lath Installation

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2021 IRC R703.7.1 Lath

- Lath and lath attachments shall be of corrosion-resistant materials in accordance with ASTM C1063-2018B. Expanded metal, welded wire, or woven wire lath shall be attached to wood framing members or furring. Where the exterior plaster is serving as wall bracing in accordance with Table R602.10.4, the lath shall be attached directly to framing. The lath shall be attached with 1-1/2-inch-long (38 mm), 11-gage nails having a 7/16 -inch (11.1 mm) head, or 7/8 -inch-long (22.2 mm), 16-gage staples, spaced not more than 7 inches (178 mm) on center along framing members or furring and not more than 24 inches (610 mm) on center between framing members or furring, or as otherwise approved. Additional fastening between wood framing members shall not be prohibited. Lath attachments to cold-formed steel framing or to masonry, stone, or concrete substrates shall be in accordance with ASTM C1063-2018B. Where lath is installed directly over foam sheathing, lath connections shall also be in accordance with Section R703.15, R703.16 or R703.17. Where lath is attached to furring installed over foam sheathing, the furring connections shall be in accordance with Section R703.15, R703.16 or R703.17.

84

https://www.dll.ca.gov/ucc/Documents/ICC-Code-Review-2018-Final-Report.pdf

84

2021 IRC R703.7.1 Lath

- Fastening pattern is to be minimum every 7" vertically on the framing members. Which is a change from 2015 code.
- "Fastening between wood framing members shall not be prohibited"
- The code has recognized it is difficult not to fasten between framing members by accident. Good practice is to reduce amount of fastener holes by trying to avoid fastening between framing members.

85

https://www.dli.pa.gov/ucc/Documents/ICC-Code-Review-2018-Final-Report.pdf

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Critical Questions

- Do fasteners between supports matter?

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Weep Screeds

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2021 IRC Section R703.7.2.1 Exterior Plaster Flashing at Foundation

- R703.7.2.l Weep screeds. A minimum 0.019-inch (0.5 mm) (No. 26 galvanized sheet gage), corrosion-resistant weep screed or plastic weep screed, with a minimum vertical attachment flange of 3 1/2 inches (89 mm), shall be provided at or below the foundation plate line on exterior stud walls in accordance with ASTM C926. The weep screed shall be placed not less than 4 inches (l 02 mm) above the earth or 2 inches (51 mm) above paved areas and shall be of a type that will allow trapped water to drain to the exterior of the building. The weather-resistant barrier shall lap the attachment flange. The exterior lath shall cover and terminate on the attachment flange of the weep screed.
- ASTMC1063 "Locate the bottom edge of the weep screed lathing accessory not less than 1 in (25mm) below the joint formed by the foundation and framing."

88

Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, Ill.

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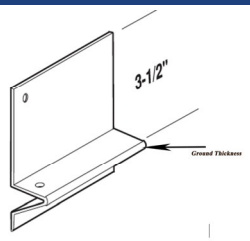
Weep Screed ASTM C1063-18B

- 7.11.4.1 Where a defined drainage space is provided "ground dimension of lathing accessories", shall accommodate the defined drainage space dimension and specified cement plaster thickness
- This means for 7/8" Stucco we need a minimum 5 mm (use ¼" drainage space) and minimum 7/8" for our stucco. Total ground thickness minimum 1 1/8" ground thickness.
- For Adhered Veneer we need a minimum 5 mm (use ¼" drainage space) minimum ½" for scratch coat. Total ground thickness minimum ¾".



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Source: ASTM International. ASTM C1063-18B Standard Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster. West Conshohocken, PA: ASTM International, 2018.

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2018 IRC Section R703.7.2.1 Adhered Masonry Veneer Section Flashing at Foundation

- R703.12.1 Clearances. On exterior stud walls, adhered masonry veneer shall be installed:
  - Minimum 4 inches (102mm) above the earth.
  - Minimum of 2 inches (51 mm) above paved areas: or
  - Minimum ½" (12.7mm) above exterior walking surfaces which are supported by the same foundation that supports the exterior wall.
- R703.12.2 Flashing at foundation. A corrosion-resistant screed or flashing of a minimum 0.019-inch (0.48mm) or 26-gage galvanized or plastic with a minimum vertical attachment flange of 3 ½ inches (89mm) shall be installed to extend a minimum of 1 inch (25mm) below the foundation plate line on exterior stud walls in accordance with Section R703.4.

90

Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, Ill.

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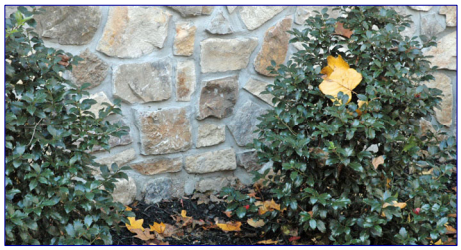
Weep Screed Not Used



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Weep Screed Installed Properly

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Critical Questions

- How big (ground dimension)?
- Where do they go?
- Do the holes matter?

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Casing Beads

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Expansion Gap Between All Dissimilar Substrates

- ASTMC1063 7.11.7 Casing Bead—Install a casing bead lathing accessory or other suitable means, at locations to separate cement plaster from dissimilar materials, penetrating elements, load bearing members and to avoid transfer of structural loads.
- ASTMC926 7.3.4 Separation shall be provided where plaster abuts dissimilar construction materials or openings. (See A2.1.3.)
- ASTMC926 A2.1.3 Sealing or caulking of V-grooves, exposed ends, and edges of plaster panels or exterior work to prevent entry of water shall be provided. "Good Practices to caulk the Joint"

Source: ASTM International. ASTM C926-18B Standard Specification for Application of Portland Cement-Based Plaster. West Conshohocken, PA: ASTM International, 2018.

Source: ASTM International. ASTM C1063-18B Standard Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster. West Conshohocken, PA: ASTM International, 2018.

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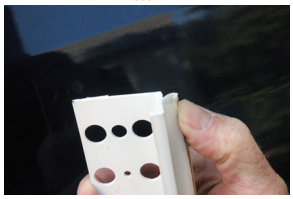
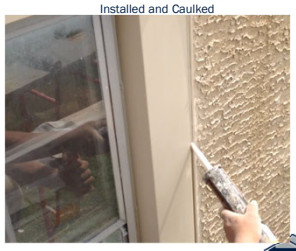
Casing Bead Installation

Casing With Expansion Flange Ready to Caulk



Installed and Caulked



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Casing Bead Installation

Casing Bead Installed

Backer Rod Inserted

97

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Casing Bead Installation All Penetrations

Integrate Under Drip Cap of Window

Installed

98

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Critical Questions

- What are casing beads?
- Are there alternatives?

99

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Summary

- **Behind stucco or adhered masonry you must:**
  - Install at least 1 layer grade D 60-minute paper.
  - Integrate WRB, flashings shingle style.
  - Isolate from dissimilar materials.
  - Install a dedicated minimum 3/16" drainage space.
  - Use self-furring wire lath.
  - Fasten to framing 7" OC with fasteners penetrating framing minimum 3/4".
  - Install weep screed at transition from foundation to framing.
    - Maintain clearances

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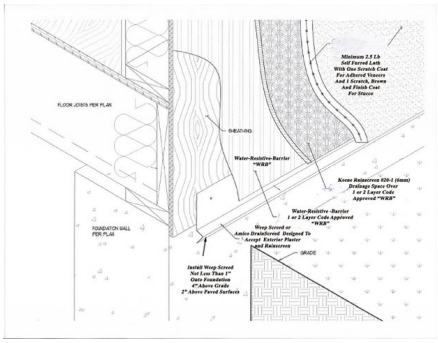

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Questions?

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A Breath of Fresh Air: Ventilation in Single-Family Homes

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Description

In an era of increasing awareness of occupant health and indoor air quality, ventilation has become a critical consideration in the design and construction of new single-family homes. As with any system in new homes, the final design is based on code requirements, performance expectations, and overall cost. This session will take a fundamental look at the role of ventilation in new single-family homes. Why is ventilation necessary? What is required in currently adopted codes? How are systems commonly designed? And when should we lean on ventilation to offer relief in times of public health crises?

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Learning Objectives

1. Why? Examine the core benefits of providing a well designed and performing ventilation system including adequate fresh air and ease of use and interaction with occupants.
2. What? Discuss the currently adopted provisions in the International Residential Code and the impact these requirements have on system design and cost.
3. How? Review common design strategies and the advantages and disadvantages of each system to constructability, performance, and occupant health.
4. When? Analyze the perception of the role of ventilation systems in the ongoing COVID-19 pandemic and compare the expected impact of adequate ventilation systems with lower-performing options.

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Why Does Indoor Air Quality Matter?

106

106

Why is Whole-House Mechanical Ventilation Needed?

107

107

The Need for Ventilation

- Modern energy codes require tighter enclosures
  BUT
- Reducing natural infiltration limits the amount of fresh air available for occupants

- "Build tight - ventilate right"
  - Perera, E., and L. Parkins. "Build tight–ventilate right." Building Services, CIBSE June (1992).

108

108

2018 IRC N1102.4.1.2 (R402.4.1.2) Testing

- The building or dwelling unit shall be tested and verified as having an air leakage rate of 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 RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pascals). Where required by the building official, testing shall be conducted by an approved third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the building official. Testing shall be performed at any time after creation of all penetrations of the building thermal envelope.

109

109

Blower Door Concept

- **Depressurize the home to an exaggerated pressure difference to quantify air infiltration and compare with established benchmarks**
- **ACH_{50} = Air Changes per Hour at pressure difference of 50 Pa**
  - Current limit in Pennsylvania is 3 ACH_{50}
  - 50 Pa simulates roughly a 20 mph wind on all sides of the home

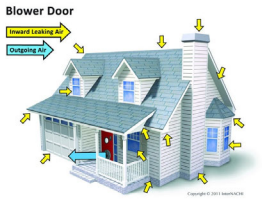

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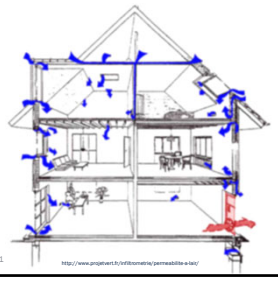
Image Source: https://www.naeci.com/blower-door-testing

110

Airtightness Requirement: 3 ACH50



- Measured in Air Changes Per Hour at 50 Pascals (ACH50 / ACH_{50})
  - 50 pascals – equivalent to 20 MPH wind on the house

Value we need (Air Changes Per Hour @ 50 Pascals) | **Value from the blower door pressure gauge** (Cubic Feet Per Minute @ 50 Pascals) | **Constant** (60 minutes per hour)

$$ACH_{50} = \frac{CFM_{50} \times 60}{V} < 3$$

Volume of the House (Cubic Feet)

111

http://www.projetvert.fr/infiltrometrie/permeabilite-a-lair/

111

2018 Ventilation Requirements

- **R303.4 Mechanical Ventilation**
  - Where the air infiltration rate of a dwelling unit is 5 air changes per hour or less where tested with a blower door at a pressure of 0.2 inch w.c (50 Pa) in accordance with Section N1102.4.1.2, the dwelling unit shall be provided with whole-house mechanical ventilation in accordance with Section M1505.4.

112

Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, Ill.

112

M1505.4: Whole-House Mechanical Ventilation System

- **M1505.4.1 System design.** The whole-house ventilation system shall consist of one or more supply or exhaust fans, or a combination of such, and associated ducts and controls. Local exhaust or supply fans are permitted to serve as such a system. Outdoor air ducts connected to the return side of an air handler shall be considered as providing supply ventilation.

113

Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, Ill.

113

M1505.4: Whole-House Mechanical Ventilation System

- **M1505.4.2 System controls.** The whole-house mechanical ventilation system shall be provided with controls that enable manual override.

114

Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, Ill.

114

M1505.4: Whole-House Mechanical Ventilation System

- **M1505.4.3 Mechanical ventilation rate.** The whole-house mechanical ventilation system shall provide outdoor air at a **continuous rate** **as determined in accordance with Table M1505.4.3(1) or Equation 15-1.**
  - *Equation 15-1: Ventilation rate in cubic feet per minute = (0.01 x total square foot area of house) + [7.5 x (number of bedrooms + 1)]*

115

Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, Ill.

115

M1505.4: Whole-House Mechanical Ventilation System

- **Exception**: The whole-house mechanical ventilation system is **permitted to operate intermittently** where the system has controls that enable operation for **not less than 25-percent of each 4-hour segment** and the ventilation rate prescribed in Table M1505.4.3(1) is multiplied by the factor determined in accordance with Table M1505.4.3(2).

116

Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, Ill.

116

2018 IRC Table M1505.4.3 (1) & (2)

TABLE M1505.4.3(1)
CONTINUOUS WHOLE-HOUSE MECHANICAL VENTILATION SYSTEM AIRFLOW RATE REQUIREMENTS

DWELLING UNIT FLOOR AREA (square feet)	NUMBER OF BEDROOMS				
	0 - 1	2 - 3	4 - 5	6 - 7	> 7
	Airflow in CFM				
< 1,500	30	45	60	75	90
1,501 - 3,000	45	60	75	90	105
3,001 - 4,500	60	75	90	105	120
4,501 - 6,000	75	90	105	120	135
6,001 - 7,500	90	105	120	135	150
> 7,500	105	120	135	150	165

TABLE M1505.4.3(2)
INTERMITTENT WHOLE-HOUSE MECHANICAL VENTILATION RATE FACTORS

RUN-TIME PERCENTAGE INEACH 4-HOUR SEGMENT	25%	33%	50%	66%	75%	100%
Factor	4	3	2	1.5	1.3	1.0

117

Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, Ill.

117

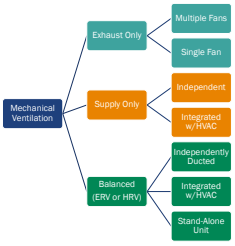
Whole-House Mechanical Ventilation Options

118

118

3 Design Solutions For Whole-House Mechanical Ventilation

- Exhaust-only
- Supply-only
- Balanced system



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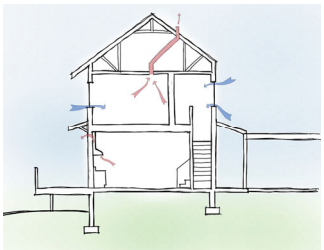
Exhaust-Only Ventilation



Source: Ventilation Requirements & Code Changes, Ventilation Science & Requirements; Hamer Center

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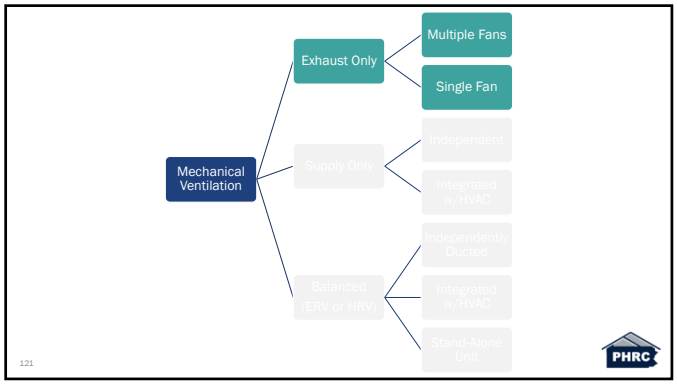

121

How Exhaust-Only Ventilation Works

- Exhaust-only ventilation systems utilize spot ventilation typically through bathroom exhaust fans
- By depressurizing portions of the home, fresh air is brought in through gaps and cracks in the envelope

122

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Exhaust-Only Option

- Programmable bath fan

Image Source: https://na.panasonic.com/us/whispergreen-selectfm-fan-50-80-110-cfm

123

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123

Exhaust-Only Placement Consideration

- **Master Bath**
  - Pathway from fan to remainder of the home
  - Noise
- **Hall Bath**
  - Pathway from fan to remainder of the home if Jack & Jill is the only option
  - More direct path for air flow

124

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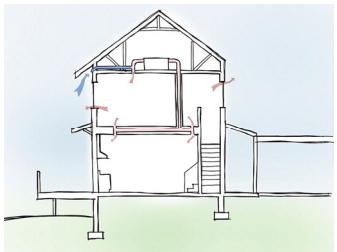
Exhaust-Only Pros/Cons

PROS	CONS
• Simple installation and minimal required duct work	• Lack of control over where the infiltrating air enters
• Affordable (low installation and operating cost)	• Outdoor air may not be evenly distributed
• Commonly used	• Must install control switch for manual override

125

125

Supply-Only Ventilation



Source: Ventilation Requirements & Code Changes, Ventilation Science & Requirements; Hamer Center

126

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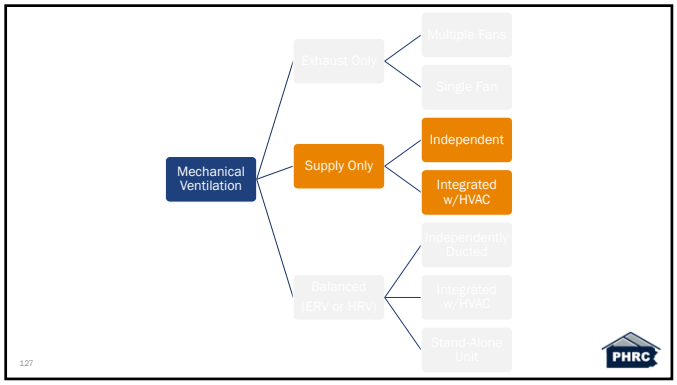

127

How Supply-Only Ventilation Works

- Supply-only ventilation typically involves a duct and fan that brings outside air into the return line of a forced air system
- The forced air system/air handler circulates the fresh air throughout the home
- By pressurizing all or portions of the home, stale indoor air is forced out through gaps & cracks

128

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128

Supply-Only Pros/Cons

PROS	CONS
• More even air distribution • Minimal addition of ductwork • Known fresh air source	• Potential to add warm, humid air into exterior walls during winter months due to pressurization • Adds additional loads to HVAC design

129

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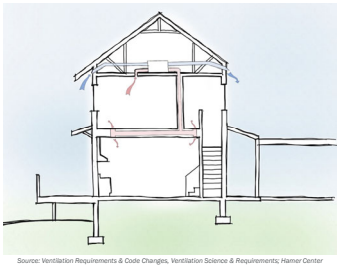
129

Balanced System Option



Source: Ventilation Requirements & Code Changes, Ventilation Science & Requirements; Hamer Center

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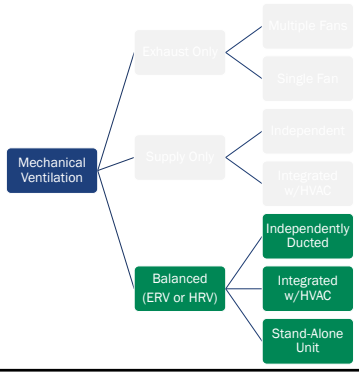

131

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131

How a Balanced System Works

- Balanced ventilation systems combine supply and exhaust systems
- Most systems have built-in heat recovery capabilities so that heat is transferred between the exhaust air and the supply air
- Some systems are also capable of transferring moisture

132

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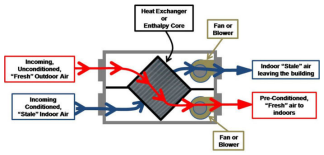
132

Heat Recovery Ventilator: What is it?

- HRVs provide balanced exhaust and supply ventilation with a heat exchanger to transfer heat between air streams



133

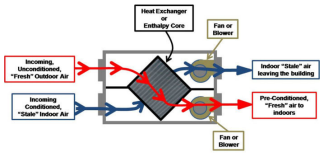
Source: https://basc.pnnl.gov/images/heat-recovery-ventilator-hrv-or-energy-enthalpy-recovery-ventilator-erv

133

133

Energy Recovery Ventilator: What is it?

- ERVs provide balanced exhaust and supply ventilation with a core that transfers heat and moisture between air streams



134

Source: https://basc.pnnl.gov/images/heat-recovery-ventilator-hrv-or-energy-enthalpy-recovery-ventilator-erv

134

134

Stand Alone System or "Spot" ERV

135

Image Source: https://na.panasonic.com/us/home-living-solutions/ventilation-indoor-air-quality/energy-recovery-ventilators/whispercomfortm

135

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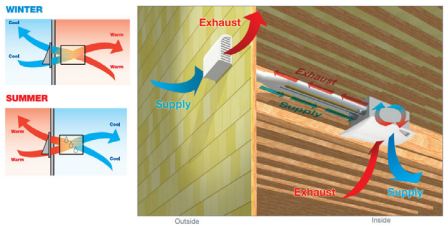
Panasonic WhisperComfort Spot ERV



136

Image Source: ftp://ftp.panasonic.com/ventilationfan/fv04ve1/whispercomfort_updated_sellsheet.pdf

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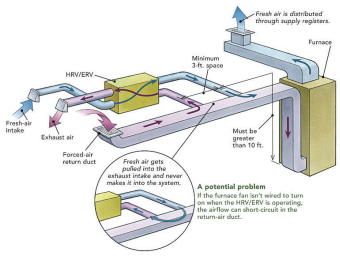
136

Integrated System: Simplified



137

Image Source: https://www.finehomebuilding.com/2014/11/05/ducting-hrvs-and-ervs

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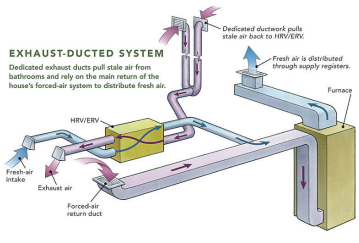
137

137

Integrated System: Exhaust-Ducted



138

Image Source: https://www.finehomebuilding.com/2014/11/05/ducting-hrvs-and-ervs

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138

Independently Ducted System

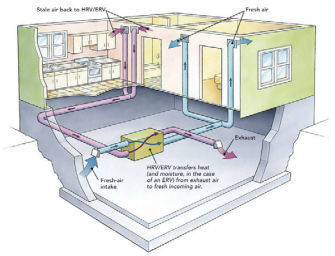

Image Source: https://www.finehomebuilding.com/2014/11/05/ducting-hrvs-and-ervs

139

139

Balanced Pros/Cons

PROS	CONS
• A balanced system transfers heat which increases comfort and decreases the load on the HVAC system • A balanced system maintains a neutral pressure difference which in turn reduces the strain on the building thermal envelope	• Highest installed cost option for whole-house mechanical ventilation • Requires regular maintenance and filter changes

140

140

Mechanical Ventilation Examples

141

141

Example #1

Small Home

- Size: 1,350 SF
- Bedrooms: 3
- Bathrooms: 1.5

142

Source: Ventilation Requirements & Code Changes, Ventilation Science & Requirements; Hamer Center

142

2018 IRC Table M1505.4.3 (1)

TABLE M1505.4.3(1)
CONTINUOUS WHOLE-HOUSE MECHANICAL VENTILATION SYSTEM AIRFLOW RATE REQUIREMENTS

DWELLING UNIT FLOOR AREA (square feet)	NUMBER OF BEDROOMS				
	0 - 1	2 - 3	4 - 5	6 - 7	> 7
	Airflow in CFM				
< 1,500	30	45	60	75	90
1,501 - 3,000	45	60	75	90	105
3,001 - 4,500	60	75	90	105	120
4,501 - 6,000	75	90	105	120	135
6,001 - 7,500	90	105	120	135	150
> 7,500	105	120	135	150	165

143

Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, Ill.

143

Example #1 Solution: Exhaust-Only

- Panasonic WhisperGreen Select fan
- Continuous rate set to 50 CFM (ramps up to 80 or 110 CFM)

144

Image Source: https://na.panasonic.com/us/us/home-living-solutions/ventilation-indoor-air-quality/ventilation-fans/whispergreenr-selection-0

144

Example #2

Medium Home

- Size: 2,300 SF
- Bedrooms: 4
- Bathrooms: 2.5

145

Source: Ventilation Requirements & Code Changes, Ventilation Science & Requirements; Hamer Center

145

2018 IRC Table M1505.4.3 (1)

TABLE M1505.4.3(1)
CONTINUOUS WHOLE-HOUSE MECHANICAL VENTILATION SYSTEM AIRFLOW RATE REQUIREMENTS

DWELLING UNIT FLOOR AREA (square feet)	NUMBER OF BEDROOMS				
	0 - 1	2 - 3	4 - 5	6 - 7	> 7
	Airflow in CFM				
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1,501 - 3,000	45	60	75	90	105
3,001 - 4,500	60	75	90	105	120
4,501 - 6,000	75	90	105	120	135
6,001 - 7,500	90	105	120	135	150
> 7,500	105	120	135	150	165

146

Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, Ill.

146

Example #2 Solution: Multiple Exhaust-Only

- Panasonic WhisperGreen Select fan
- Two w/continuous rate set to 40 CFM (ramps up to 80 or 110 CFM)

147

Image Source: https://na.panasonic.com/us/us/home-living-solutions/ventilation-indoor-air-quality/ventilation-fans/whispergreenr-selection-0

147

Example #2 Solution: Spot ERVs

- Panasonic WhisperComfort spot ERVs
- Each ERV set to 40 CFM

148

Image Source: https://na.panasonic.com/us/home-living-solutions/ventilation-indoor-air-quality/energy-recovery-ventilators/whispercomfortm

148

Example #3

Large Home

- Size: 5,300 SF
- Bedrooms: 6
- Bathrooms: 4

149

Source: Ventilation Requirements & Code Changes, Ventilation Science & Requirements; Hamer Center

149

2018 IRC Table M1505.4.3 (1)

TABLE M1505.4.3(1)
CONTINUOUS WHOLE-HOUSE MECHANICAL VENTILATION SYSTEM AIRFLOW RATE REQUIREMENTS

DWELLING UNIT FLOOR AREA (square feet)	NUMBER OF BEDROOMS				
	0 - 1	2 - 3	4 - 5	6 - 7	> 7
	Airflow in CFM				
< 1,500	30	45	60	75	90
1,501 - 3,000	45	60	75	90	105
3,001 - 4,500	60	75	90	105	120
4,501 - 6,000	75	90	105	120	135
6,001 - 7,500	90	105	120	135	150
> 7,500	105	120	135	150	165

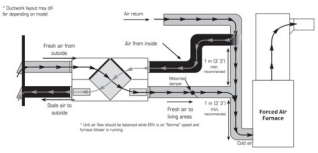
150

Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, Ill.

150

Example #3 Solution: HRV

- Fantech SHR150 Integrated HRV
  - Max airflow = 159 CFM
  - Controls installed to set airflow rate



151

Source: http://www.fantech.net/products/residential-fresh-air-systems/fresh-air-appliances/horizontal-appliances/shr/shr150-fffc3bd0/

151

151

Additional Considerations

- Equipment cost
- Installation cost
- Homeowner education & maintenance
  - Filters, controls, etc.

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Summary

- Whole-house mechanical ventilation systems are mandatory for new homes in PA under the UCC and Industrialized Housing Act
- 3 main types of systems
  - Exhaust-only
  - Supply-only
  - Balanced system
- All systems have their pros & cons – decision should be based on performance & cost

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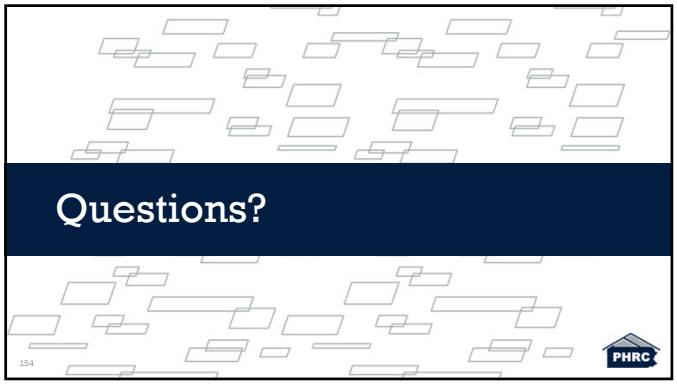

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