November 13th, 2018 – Christopher Hine

Air Sealing for 5 ACH_{50}

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Description

- Pennsylvania's prescriptive air leakage requirements have recently been changed from 7 ACH_{50} to 5 ACH_{50}. With this change, builders may have to modify their air sealing package to comply with the prescriptive air infiltration requirements. In this webinar we will look at areas of concern for air leakage and review several techniques to potential seal those areas.

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Learning Objectives

- Review the 2015 IRC and IECC requirements on air leakage
- Understand the physical transition of a home with a higher leakage rate to a home with a lower leakage rate and how that change can affect the sustainability of building components
- Learn why air sealing is important to the occupant comfort and health by not allowing air infiltration from potentially contaminated areas
- Review air sealing techniques that can help achieve this lower prescriptive standard

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Building Science

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Building Science Fundamentals

- Air leakage - significant source of heat loss (convection)
- Air sealing often considered most cost-effective way to save energy in a house
- Intent: Create a controlled air exchange

"Let the House Breathe"

VS.

"Build Tight / Ventilate Right"

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Air Pressure

- Air tends to move from high pressure to low pressure
- Differences in pressure result in pressurization or depressurization of spaces
- Take the path of least resistance

- Causes
  - Naturally occurring phenomena
  - Mechanical system operation

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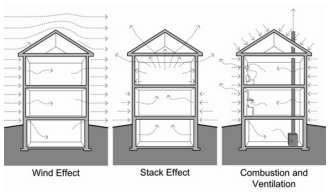
Wind

- Positive Pressure at Windward side
- Negative Pressure at Leeward side

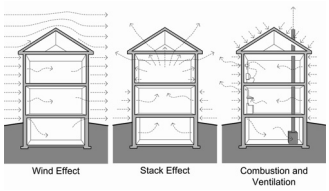


"BSD-014: Air Flow Control in Buildings" (Building Science Corporation)

13

Stack Effect

- **Hot air rises**
  - Exfiltration above Neutral Pressure Plane
  - Infiltration below Neutral Pressure Plane



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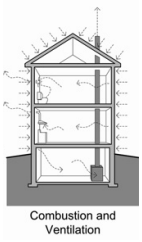
"BSD-014: Air Flow Control in Buildings" (Building Science Corporation)

Mechanical System Operation

- **Bath fans**
- **Dryer exhaust**
- **Range hoods**
- **HVAC units**
  - Duct leakage can pressurize or depressurize depending on the location of the leaks
    - Supply side leaks = depressurization
    - Return side leaks = pressurization



15

Effects of Pressure Differences

- **Unwanted air drawn from attic, crawlspace, storage areas, garage**
  - Stale, stagnant
  - Pollutants
  - Moisture
- **Unwanted heat transfer**
  - Uncomfortable drafts
- **Moisture into building cavities**
- **Backdrafting**
  - Exhaust from combustion appliances enters house

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Managing Air Flow

- Create a continuous air barrier
- Low air permeance
  - Permeance is a measure of the system
  - Permeability is a measure of the material
- Air barrier vs Vapor barrier vs Vapor retarder
  - Housewrap can be an air barrier and a vapor retarder
  - Bare drywall is an air barrier but not a vapor retarder
  - Poly is an air barrier and a vapor barrier

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Air Barriers

- Air barrier defined by ABAA as maximum permeance of 0.004 cfm/ft2 @ 1.57 psf (0.02L/sm2 @ 75 Pa)
- No quantifiable definition in ICC codes
  - Material(s) assembled and joined together to provide a barrier to air leakage through the building envelope
- Must be a continuous barrier
  - More important to be continuous than the vapor retarder
    - i.e. Must tape housewrap for air barrier vs. Lapped seams enough for vapor retarder

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Air Barrier Materials

- 1/2" Drywall
- Mechanically Fastened Housewrap
- Plywood / OSB
- XPS rigid foam sheathing
- Spray foam insulation
- Spray-applied air barriers
- Self-Adhered Sheet air barriers
- Concrete
- Polyethylene

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Air Sealing

- Creating an Air Barrier System
  - Properly limiting air infiltration requires a continuous air barrier at the building enclosure
  - Achieved with tape, caulk, adhesive, gasket, foam
    - Assembly perimeter (wall/attic, wall/floor, wall/foundation)
    - Penetrations, seams, etc.

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2015 IRC and Air Sealing

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Current Code Requirements

- 2015 International Residential Code
  - Chapter 11: Energy Efficiency
- 2015 International Energy Conservation Code
  - Chapter 4 in the Residential Provisions

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N1102.4 Air Leakage

- The building thermal envelop shall be constructed to limit air leakage in accordance with the requirements of Sections R1102.4.1 through R1102.4.4

23

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

N1102.4.2 Fireplaces

- New wood-burning fireplaces shall have tight-fitting flue dampers or doors, and outdoor combustion air.

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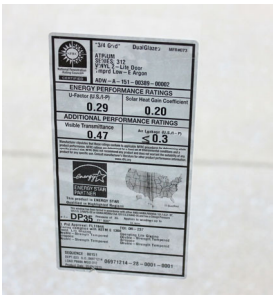
Source: International Code Council (ICC). (2014). 2015 International Residential Code, Country Club Hill, Ill.

N1102.4.3 Fenestration Air Leakage

- Windows, skylights and sliding glass doors shall have an air infiltration rate of no more than 0.3 cfm per square foot and swinging doors no more than 0.5 cfm per square foot.

25

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



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N1102.4.4 Rooms Containing Fuel-Burning Appliances

- Where open combustion air ducts provide combustion air to open combustion fuel-burning appliances, the appliances and combustion air opening shall be located outside the building thermal envelope or enclosed in a room, isolated from inside the thermal envelope.

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

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N1102.4.1 – Building Thermal Envelope

- The building thermal envelope shall comply with Sections N1102.4.1.1 and N1102.4.1.2. The sealing methods between dissimilar materials shall allow for differential expansion and contraction.
  - N1102.4.1.1 – Installation
  - N1102.4.1.2 - Testing

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

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2009 N1102.4.2: Air Leakage Demonstration

- **N1102.4.2 – Air sealing and insulation. Building envelope airtightness and insulation installation shall be demonstrated to comply with one of the following options:**
  - N1102.4.2.1 – **Testing option.** Tested air leakage is less than 7 ACH when tested with a blower door at a pressure of 50 pascals.

    OR
  - N1102.4.2.2 – **Visual Inspection**

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

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N1102.4.1.2 Testing

- **2015 IRC N1102.4.1.2 (IECC R402.4.1.2) Testing (of air leakage)**
  - The building **shall be tested and verified** as having an air leakage rate of **not exceeding 5 ACH50**. Testing shall be performed at any time after the creation of all penetrations of the building thermal envelope.

30

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

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Testing With a Blower Door

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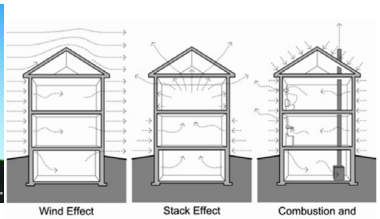
Basics of Airtightness: Where and How?

https://www.hgtv.com/remodel/mechanical-systems/home-energy-audit-evaluating-efficiency-pictures



https://www.energycodes.gov/sites/default/files/documents/BECP_Building%20Energy%20Code%20Resource%20Guide%20Air%20Leakage%20Guide_Sept2011_v00_lores.pdf

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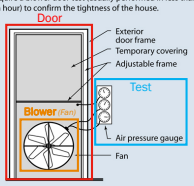
Blower Door Setup

Diagnostic Tools

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



http://hvacservices.com/blower-door-testing.php

- Set up on an exterior door
- Adjustable frame & cover for any size single exterior door
- Air pressure gauge
- Fan with adjustable rings for nearly all SF buildings
- Fan power cord (standard outlet)

http://www.ci.fridley.mn.us/170/Home-Improvements-Loans

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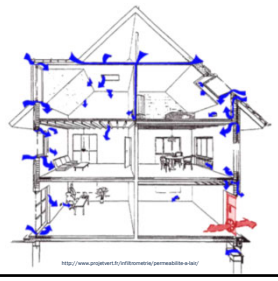
Airtightness Requirement: 5 ACH50



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

- 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)

$$ACH_{50} = \frac{CFM_{50} \times 60}{V} < 5$$

Volume of the House (Cubic Feet)

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N1102.4.1.1 Installation

- The components of the building thermal envelope as listed in Table N1102.4.1.1 shall be installed in accordance with the manufacturer's instructions and the criteria listed in Table N1102.4.1.1, as applicable to the method of construction. Where required by the building official, an approved third party shall inspect all components and verify compliance.

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

Table N1102.4.1.1 Air Barrier and Insulation Installation

- General requirements
- Ceiling/attic
- Walls
- Windows, skylights and doors
- Rim joists
- Floors
- Crawl space walls
- Shafts, penetrations
- Narrow cavities
- Garage separation
- Recessed lighting
- Plumbing and wiring
- Shower / tub on exterior wall
- Electrical / phone box on exterior walls
- HVAC register boots
- Concealed sprinklers

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

General Requirements

- Air Barrier Criteria
  - A continuous air barrier shall be installed in the building thermal envelope.
  - The exterior thermal envelope contains a continuous air barrier.
  - Breaks or joints in the air barrier are filled or repaired.
- Insulation Installation Criteria
  - Air-permeable insulation is not used as a sealing material.

37

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

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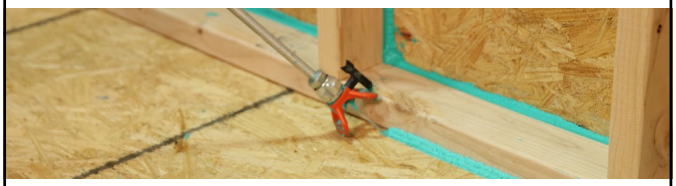

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Image Source: http://www.touch-n-seal.com/airstop.html

Ceiling/Attic

- **Air Barrier Criteria**
  - Air barrier in any dropped ceiling/soffit shall be aligned with the insulation and any gaps in the air barrier sealed.
  - Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed.
- **Insulation Installation Criteria**
  - The insulation in any dropped ceiling/soffit shall be aligned with the air barrier.

40

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

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Image Source: https://americorpsprojectconserve.wordpress.com/category/service-project/

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Walls

- **Air Barrier Criteria**
  - 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.
- **Insulation Installation Criteria**
  - Cavities within corners and headers of frame walls shall be insulated by completely filling the cavity with material having an R-value of R-3 per inch min.
  - Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier.

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

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Image Source: https://www.jlconline.com/how-to/exteriors/sealing-the-foundation-to-the-framing_o

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Windows, Skylights and Doors

- **Air Barrier Criteria**
  - The space between window/door jambs and framing, and skylights and framing shall be sealed.
- **Insulation Installation Criteria**

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

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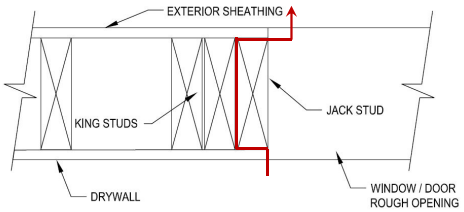
Air Leakage Between Studs



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Rim Joists

- **Air Barrier Criteria**
  - Rim joists shall include the air barrier.
- **Insulation Installation Criteria**
  - Rim joists shall be insulated

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

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Floors

- **Air Barrier Criteria**
  - The air barrier shall be installed at any exposed edge of insulation.
- **Insulation Installation Criteria**
  - 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.

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

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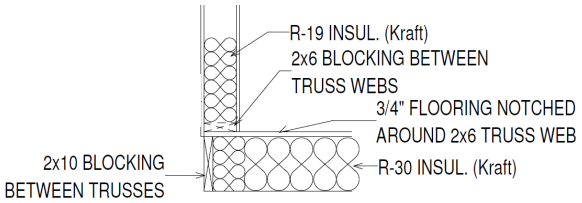

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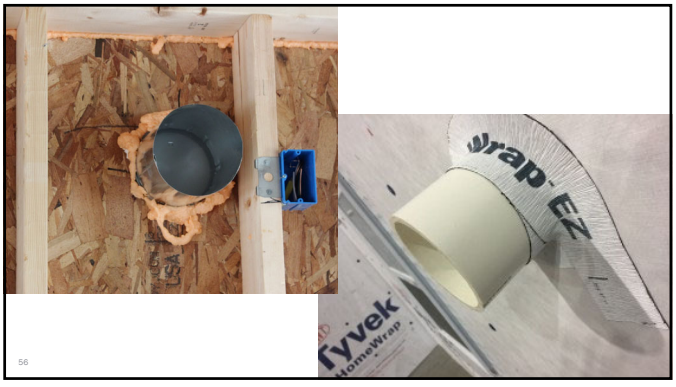
Shafts, Penetrations

- **Air Barrier Criteria**
  - Duct shafts, utility penetrations, and flue shafts openings to exterior or unconditioned space shall be sealed.
- **Insulation Installation Criteria**

55

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



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Garage Separation

- **Air Barrier Criteria**
  - Air sealing shall be provided between the garage and conditioned spaces.
- **Insulation Installation Criteria**

58

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

59

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Recessed Lighting

- **Air Barrier Criteria**
  - Recessed light fixtures installed in the building thermal envelope shall be sealed to the drywall.
- **Insulation Installation Criteria**
  - Recessed light fixtures installed in the building thermal envelope shall be air tight and IC rated.

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

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Shower/Tub on Exterior Walls

- **Air Barrier Criteria**
  - The air barrier installed at exterior walls adjacent to showers and tubs shall separate them from the showers and tubs.
- **Insulation Installation Criteria**
  - Exterior walls adjacent to showers and tubs shall be insulated.

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

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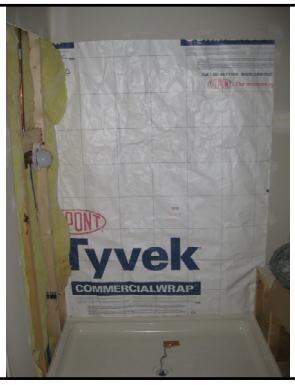

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HVAC Register Boots

- **Air Barrier Criteria**
  - HVAC register boots that penetrate building thermal envelope shall be sealed to the subfloor or drywall.
- **Insulation Installation Criteria**

66

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

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Image Source: http://www.airdoctor.org/air-duct-sealing.html

Now That We Know, Where Do We Go?

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Who Needs to Know About Air-Sealing?

- On average 22 subcontractors are involved in the construction of a new home.

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Who Fills It?

- Ceiling/attic, attic access, recessed lights, walls, floors, common walls & service entrances
  - Insulation / air sealing installers
  - Drywall contractors
  - Foundation contractors
  - Electricians
  - Roofers
  - Framers
  - General contractors

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Source: www.insulationinstitute.org

Who Fills It?

- Service water piping, penetrations for water supply
  - Plumbers
  - Electricians

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Source: www.insulationinstitute.org

Who Fills It?

- Rim joist, sill plates, windows, skylights, doors, tub/shower on exterior walls & fireplace
  - Framers
  - Roofers
  - Plumbers
  - Electricians
  - Insulation / air sealing installers
  - Window and door installers
  - General contractors
  - HVAC installers
  - Inspectors

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Source: www.insulationinstitute.org

Who Fills It?

- Ducts, piping, shafts, penetrations, register boots
  - HVAC installers
  - Inspectors
  - Framer
  - General contractors

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Source: www.insulationinstitute.org

Summary

- Due to the new requirement for Blower Door testing, air sealing details that might be overlooked are now going to come to light
- Pay close attention to detail when air sealing
- All subcontractors need to understand their role in air sealing

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