Nebraska Energy Code Training:

Duct & Envelope Testing

Instructor: Matt Belcher

May 15, 2024

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Housekeeping

- Attendees are muted upon entry
- Questions? Enter them in the chat box
- Webinar is being recorded – slides and recording will be sent to attendees
- CEU's will be available upon request (ICC and AIA)
  - Information at end of presentation
- Email: jgossman@mwalliance.org with questions

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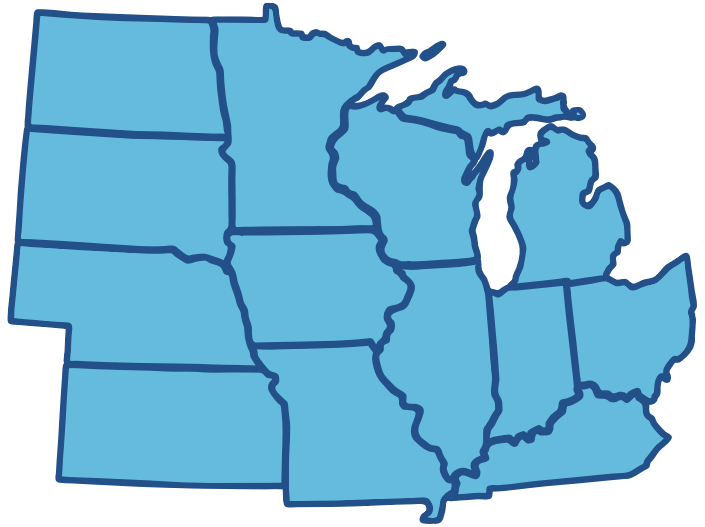
Midwest Energy Efficiency Alliance

The Midwest Energy Efficiency Alliance (MEEA) is a collaborative network, promoting energy efficiency to optimize energy generation, reduce consumption, create jobs and decrease carbon emissions in all Midwest communities.



MEEA is a non-profit membership organization with 150+ members, including:

Energy service companies & contractors

State & local governments

Academic & research institutions

Electric & gas utilities

About the Nebraska Training Program

- Goal: prepare the Nebraska workforce for upcoming changes in construction best practices
  - Residential and Commercial Energy Code
  - Building Science
  - Practical Solutions

- Focused on providing training to builders, code officials, design professionals, public officials and students

- For more information, visit: https://www.mwalliance.org/nebraska-energy-codes-training-program

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Overview DET

- Defining the Building Envelope Commercial/Residential
- Applied Building Science to Envelope Performance (Leakage, Air transfer)
- Energy Code Requirements
  - Air Barrier
- Compliance Paths
- ASHRAE 90.1 as Referenced by IECC
- Testing/Compliance
- Existing Buildings

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Defining the building Envelope

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Building Envelope

The building envelope is what ***separates the inside from the outside***

It is defined as any building element assembly that encloses conditioned space or ***provides a boundary*** between conditioned space and exempt or non-conditioned space

The building envelope includes: below grade (basement) walls, exterior walls, windows, doors, floors, ceilings, roofs, etc.

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Building Envelope

The building envelope must serve four functions:

1. Keep bulk moisture out.
2. Handle moisture as vapor.
3. Contain air movement.
4. Contain heat.

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Building Envelope: Control Layers

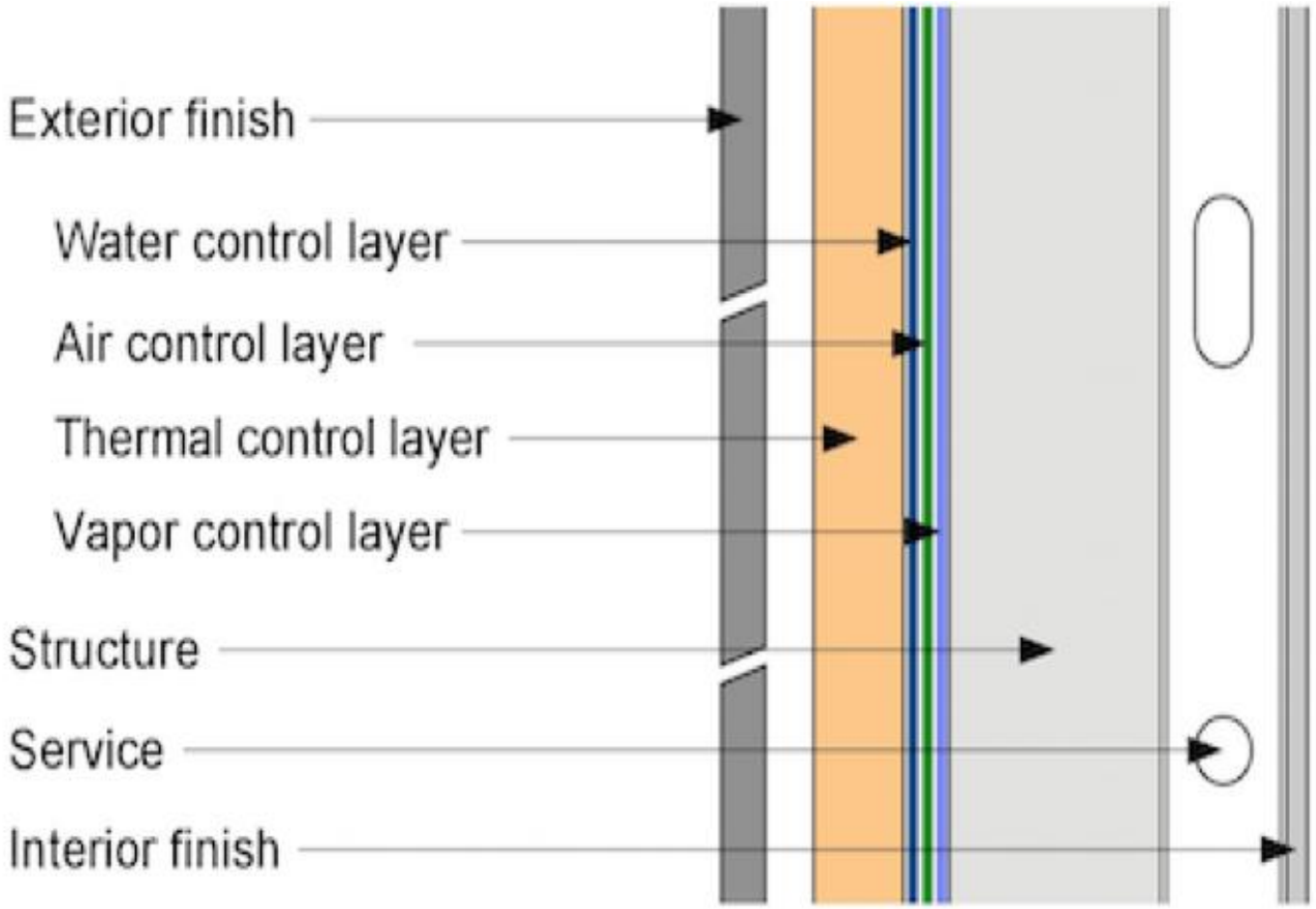
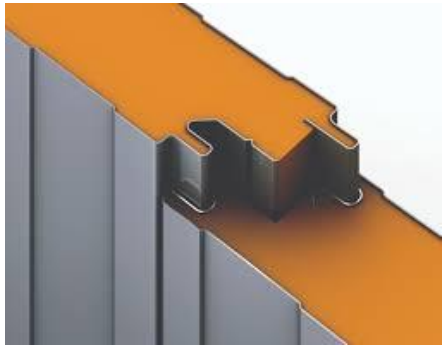


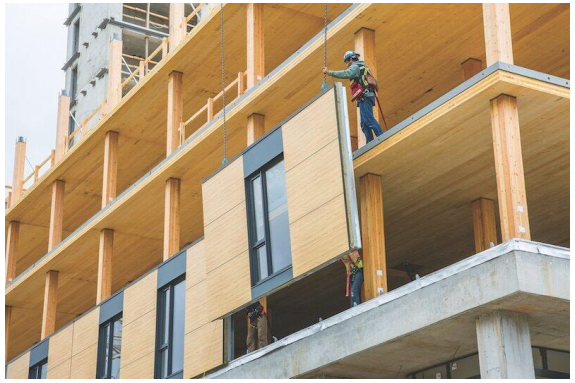
Image: Green Building Solutions

Building Envelope: Many Wall Types

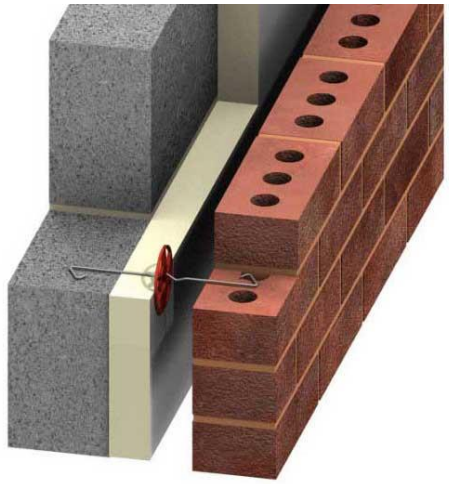


Insulated Panel

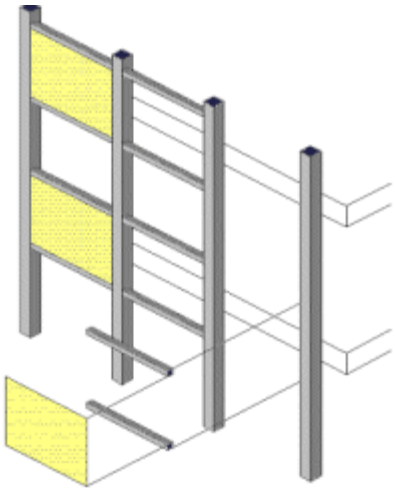
Steel Stud / Exterior Sheathing



Mass Timber



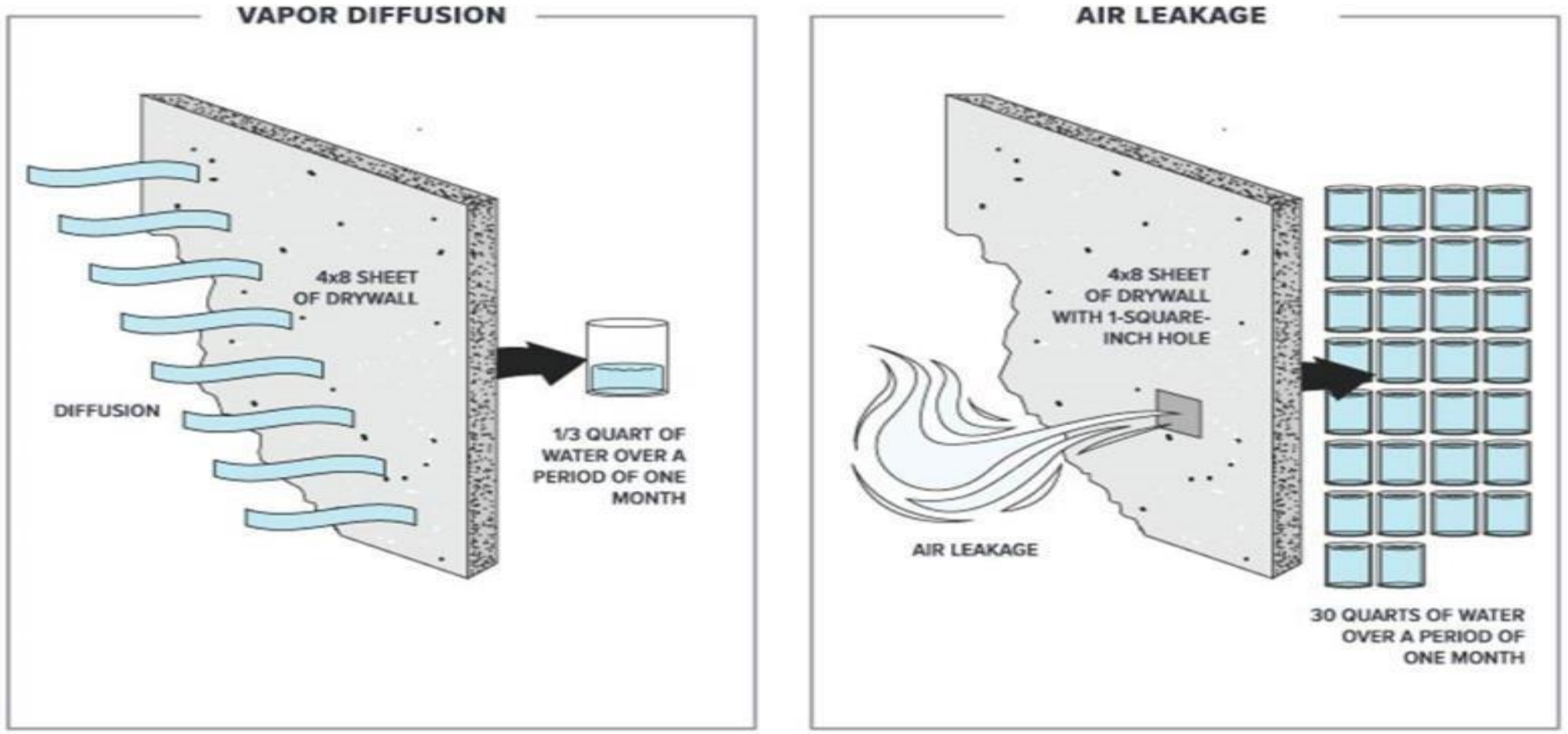
Cavity Wall



Stick-Built Curtain Wall

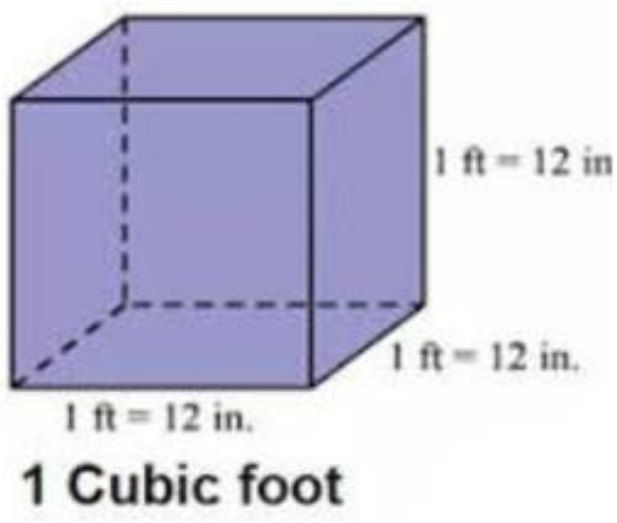
Images: mrfixitbali.com; google.com; Building Design+Construction; metalconstructionnews.com; buildgp.com

Vapor Diffusion vs. Air Leakage



AIR LEAKAGE

- Airflow is measured in cubic feet per minute, also written as ft^3/min, or CFM.
- 1 CFM out = 1 CFM in
- Airflow takes the path of least resistance.
- Air moves from high to low pressure areas.
- Warm air rises, cool air sinks.



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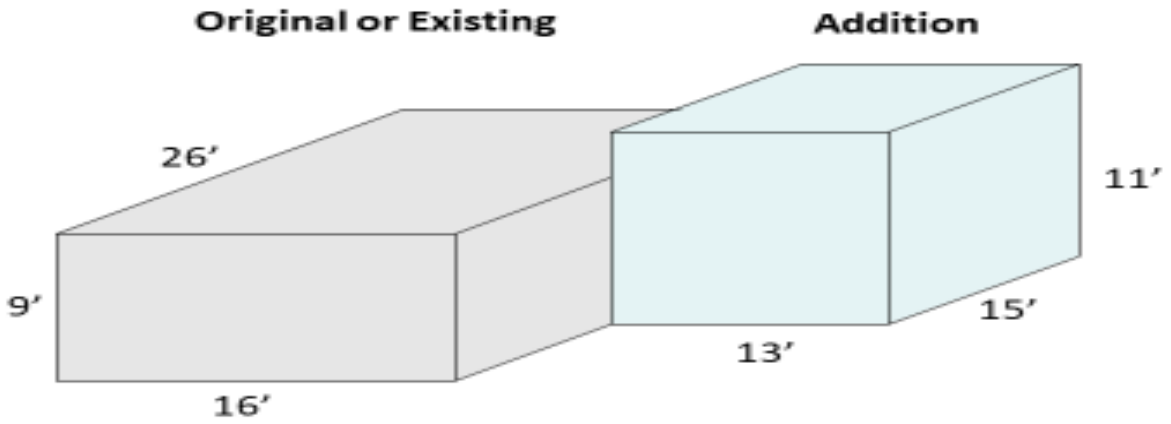
AIR LEAKAGE

Volume



This Building has an addition, what is the total volume of the entire Building?

$Volume_1$ is = 3,744 ft^3

$Volume_2$ is = 2,145 ft^3

Total Volume is = 5,889 ft^3

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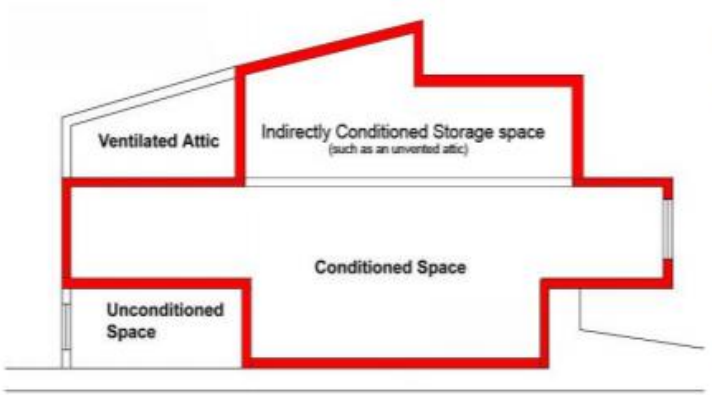
ENVELOPE LEAKAGE RATIO @ 75 PA "ELR75" – A BETTER METRIC

- Leakage occurs through shell of building (not through volume)
- Normalizing leakage at 75Pa (0.3 in w.c.) based on shell area is most common for commercial buildings



Building Thermal Envelope

The building thermal envelope is the portion of the building envelope that is comprised of the continuous air barrier and insulation and separates conditioned space from unconditioned space.

Example Calculation

A 7,600 square foot building (First floor: 3,600 square feet and second floor: 4,000 square feet) has a shell area of 13,920 square feet. The blower door test measures a flow of 3,340 CFM_{75}.

What is the Envelope Leakage Ratio at 75 Pa?

ELR75 is calculated by dividing the measured CFM75 by the total shell area of the envelope.

$$\textbf{Shell Area} = 4000ft^2 + 4000ft^2 + 5920ft^2 = \mathbf{13,920}ft^2$$

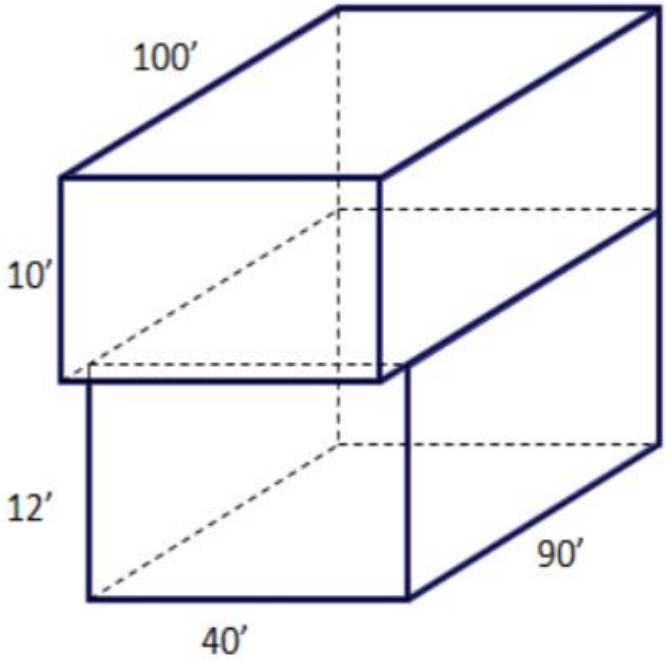
$$\textbf{BD Fan Flow Measurement} = \mathbf{3,340}\ CFM_{75}$$

$$ELR_{75} = \frac{CFM_{75}}{Shell\ Area}$$

$$ELR_{75} = \frac{3{,}340\ CFM_{75}}{13{,}920\ sf}$$

$$ELR_{75} = 0.24$$

Envelope passes program requirement and earns additional points



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Applied Building Science to the Building Envelope

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(Not so) Advanced Physics in Building Science:

Heat

Hot → Cold

Moisture

Wet → Dry

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Moisture Flows Four Ways

#1 – Bulk water

#2 – Capillary water

#3 – Air-transported moisture

#4 – Diffusive moisture movement

Moisture Flows Four Ways
Air Transported Moisture – Priority #3

AIR BARRIER

- Air movement leads to both energy loss and moisture transmission.
- The air barrier prevents air movement through all parts of the envelope and must be continuous.
- Primary air barrier:
  - Exterior sheathing (e.g. Zip System, etc.)
  - Building wrap (e.g. Tyvek, etc.)
  - Seam sealing
  - Interior drywall
- Penetrations in the primary air barrier create air leaks and must be properly sealed.

Image: westerlyalberta.com

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Moisture Flows Four Ways
Air Transported Moisture – Priority #3

- Uncontrolled / unknown holes that allow air into or out of a building have a negative impact on the building and its occupants.
  - 1/3 quart of water through solid gypsum board but 30 quarts through 1 in^2 hole!
- Minimizing envelope air leakage must be a primary goal of the building envelope.
- Energy efficient buildings have a low leakage rate.
- Controlled ventilation / fresh air intake from a known source improves indoor air quality and contributes to occupant health.

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Building Envelope Code Requirements

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General Requirements

Section C402.1

Building thermal envelope to comply with the following:

- Specific insulation requirements of Section C402.2
- Thermal requirements of either:
  - R-value-based method of Section C402.1.3
  - U-, C-, and F-factor-based method of Section C402.1.4 **OR**
  - Component performance alternative of Section C402.1.5
- Fenestration in building envelope assemblies
- Air Leakage of building envelope assemblies

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IECC and IMC

- Whole-house mechanical ventilation required by energy code
- Ventilation rate and equipment requirements in the International Mechanical Code (IMC)

Mandatory Requirements

- Air Leakage
- Air barriers
- Fenestration air leakage
- Rooms Containing Fuel-burning Appliances
- Air intakes, exhaust openings, stairways and shafts
- Loading dock weatherseals
- Vestibules
- Recessed lighting

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Air Leakage
Section C402.5 (Mandatory)

- Envelope air sealing requirements must be met by:
  - Testing (blower door) in accordance with ASTM E 779 at pressure differential of 0.3 inch water gauge or an equivalent method approved by code official when tested air leakage rate < 0.40 cfm/ft^2

OR

  - Compliance with Sections C402.5.1 through 5.8

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Air Barrier Construction
Section C402.5.1.1 (Mandatory)

- Air barrier placement allowed:
  - Inside of building envelope
  - Outside of building envelope
  - Located within envelope assemblie

    OR

  - Any combination thereof
- Must be continuous for all assemblies and joints that are part of the envelope

Image: wrmeadows.com

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Vestibules
Section C402.5.7 (Mandatory)

- Required to reduce infiltration into spaces
- Required for doors leading into spaces ≥ 3,000 ft^2
- Doors must have self-closing devices
- **Exceptions:**
  - Buildings in Climate Zones 1 and 2
  - Doors from a sleeping unit or dwelling unit
  - Revolving doors (adjacent swing doors are not exempted)
  - Doors that have an air curtain meeting requirements

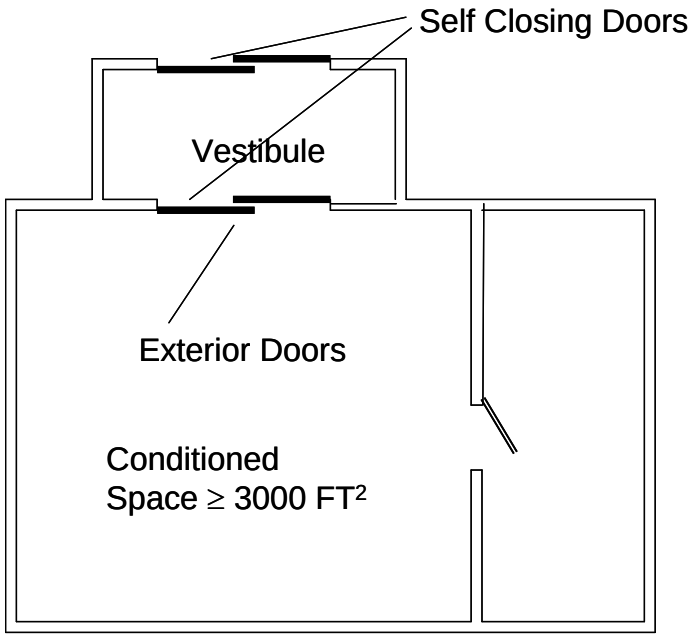

Image: U.S. Dept of Energy

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Additional Efficiency Package Options
Section C406

- Buildings shall comply with one or more of the following:
  - More efficient HVAC performance
  - Reduced lighting power
  - Enhanced lighting controls
  - On-site renewable energy
  - Dedicated outdoor air system
  - High efficiency water heating
  - Enhanced envelope performance
  - Reduced air infiltration

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Additional Efficiency Package Options
Section C406

- Reduced Air Infiltration
  - Whole building pressurization testing (ASTM E779 or ASTM E1827) by independent third party
  - Measured leakage rate of ≤ 0.25 cfm/ft^2 (code minimum is ≤ 0.40 cfm/ft^2)
  - Buildings over 250,000 square feet of conditioned floor area may conduct representative area testing
    - Test not less than 25% of conditioned floor area

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ASHRAE 90.1 2016 Section 5: Building Envelope Overview

- **ASHRAE 90.1 is an optional compliance path allowed in the 2018 IECC (Section C401.2).**
- Applies to:
  - New, and new portions of, *buildings* and their *systems*
  - *Additions* and *alterations* to existing buildings
  - New *systems* and *equipment* in *existing buildings*
- Does not apply to:
  - Single-family houses, low-rise multi-family ≤ 3 stories above *grade*, manufactured houses (mobile or modular)
  - *Buildings* that use neither *electricity* nor *fossil fuel*
- Does not circumvent any safety, health, or environmental requirements

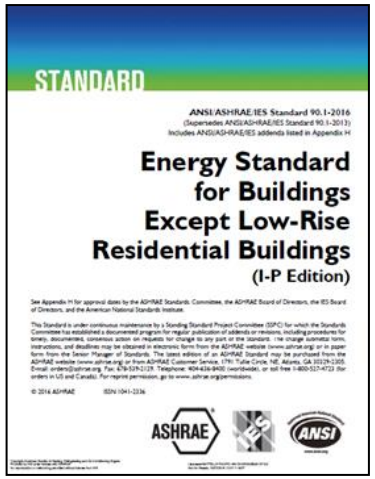

Image: ASHRAE.org

Structure of Standard 90.1-2016

1. Purpose
2. Scope
3. Definitions, Abbreviations, and Acronyms
4. Administration and Enforcement
5. Building Envelope
6. Heating, Ventilating, and Air Conditioning
7. Service Water Heating
8. Power
9. Lighting
10. Other Equipment
11. Energy Cost Budget Method
12. Normative References

Normative Appendices A-H
Appendix G – is a new compliance path!

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Performance Testing

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Air Leakage & Continuous Air Barrier Testing
Section C402.5

- Continuous Air Barrier Required
- Two Compliance Options
  - ASTM E 779 (blower door test)
  - Compliant assemblies
    - C402.5.1 through C402.5.8

Image: energyconservatory.com

Building Envelope Leakage

Residential DET
Energy Code Requirements

The 2018 IECC-R

IRC Chapter 11

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Air Sealing, Testing & Ventilation | R402.4

- **2009 IECC** Requirement: 7 ACH50 (testing optional)
  - Mechanical Ventilation not required
- **2015 IECC** Requirement: 5 ACH50 (testing Required)
- **2018 IECC** Requirement: 3 ACH50 (testing required)
  - Mechanical ventilation required and is critical!
    - Exhaust, Supply or Balanced Ventilation
    - As simple as a continuous bath fan
- ✓ **2021 IECC** Requirement: 3 ACH50 (No Real Change)

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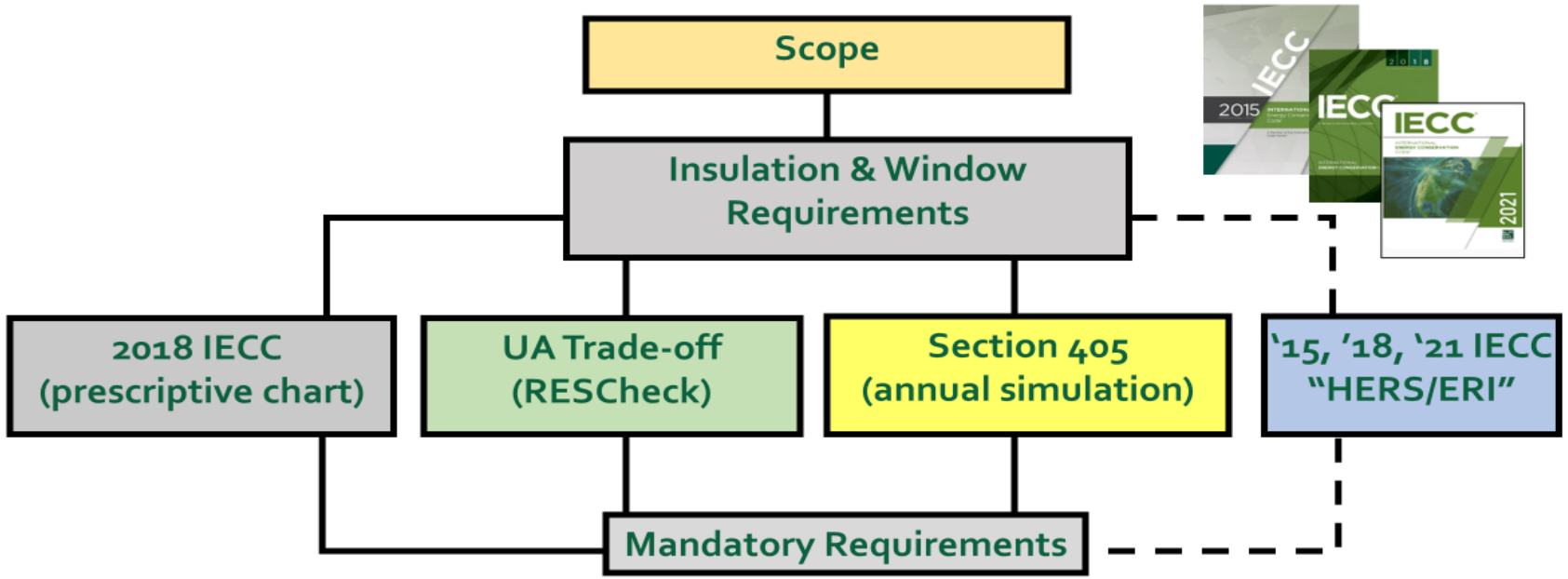
COMPLIANCE PATHS FOR INSULATION & WINDOWS



- The Energy Rating Index (ERI) path gives the most design flexibility (e.g., credit for mechanical equipment efficiency)
- It credits items not covered by the code (e.g., appliance efficiencies)
- In '21 IECC, can back off air leakage to < 5 ACH50

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Importance of Air Sealing

- You can not control the indoor environment if you let the outside in
- Continuous air barrier and thermal barrier are essential
- They will define the HVAC system requirements
- The only way to know envelope tightness is a blower door test

Images: barriersciences.com; energy.gov

Air Barrier

- Primary air barrier:
  - Exterior sheathing
  - House wrap
  - Seam sealing
  - Interior drywall
- Penetrations in the primary air barrier create air leaks.
- *2018 IECC requires blower door test*
  - ***Maximum leakage: 3 ACH50***
  - ***Average Air Leakage Rate in NE: 2.8 ACH50***

Image: huberwood.com

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Air Barrier - Strategies

- Drywall glued to the studs and plates
- Lapped and taped joints
- Close alignment with insulation
- Sealed air permeable insulation
- Taped or caulked sheathing seams
- Caulked or foam-sealed outlets, penetrations, sill plates, windows and doors

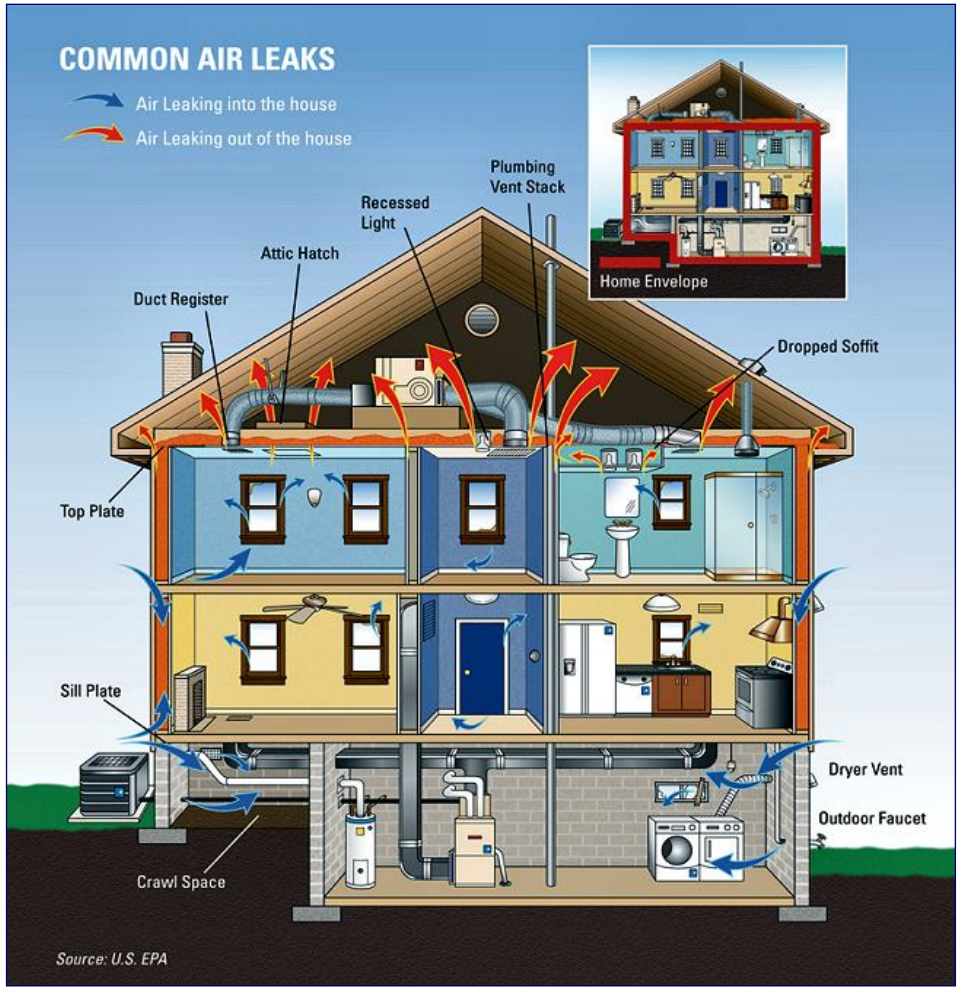

Image: epa.gov

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Air Barrier – Strategies (cont.)

- Sealed joist bays
- Sealed HVAC supply and return outlets
- Sealed soffits and chases
- Sealing around the backside of tubs, knee walls and garages
- Sealed off garages
- Sealed recessed lighting cans

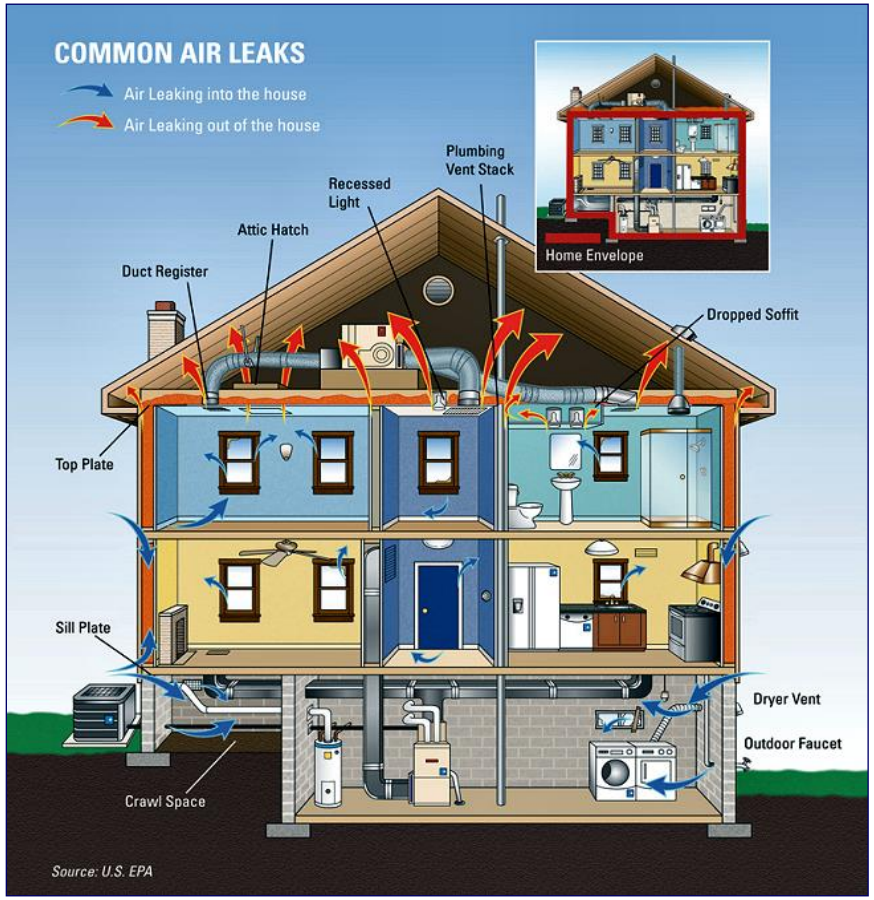

Image: epa.gov

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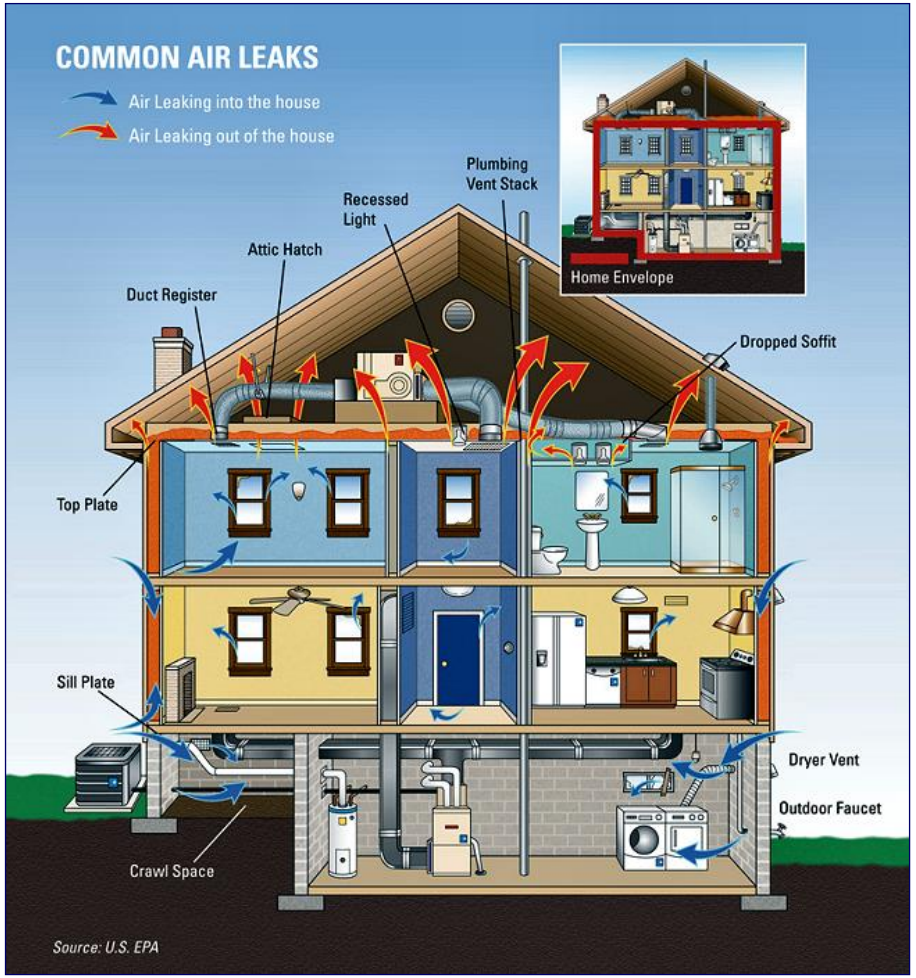
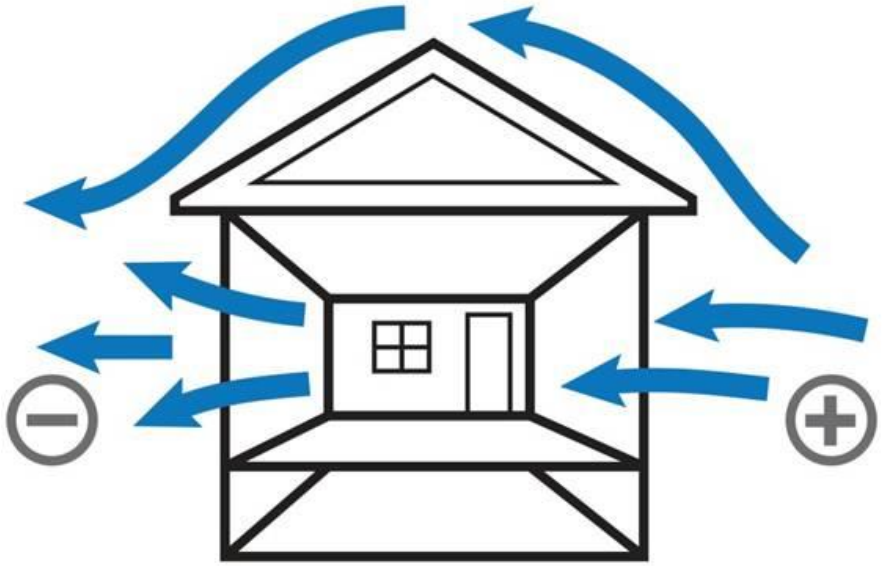
Review - Air Barrier Strategies

- Sealed joist bays
- Sealed HVAC supply and return outlets
- Sealed soffits and chases
- Sealing around the backside of tubs, knee walls and garages
- Sealed off garages
- Sealed recessed lighting cans

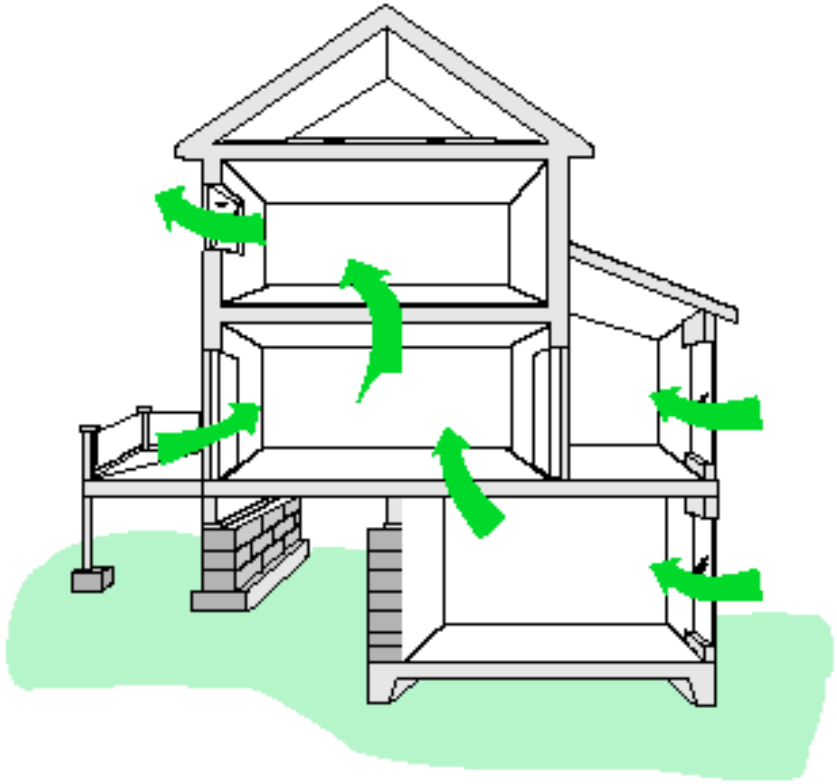


Courtesy of U.S. Environmental Protection Agency

Natural Driving Forces for Infiltration



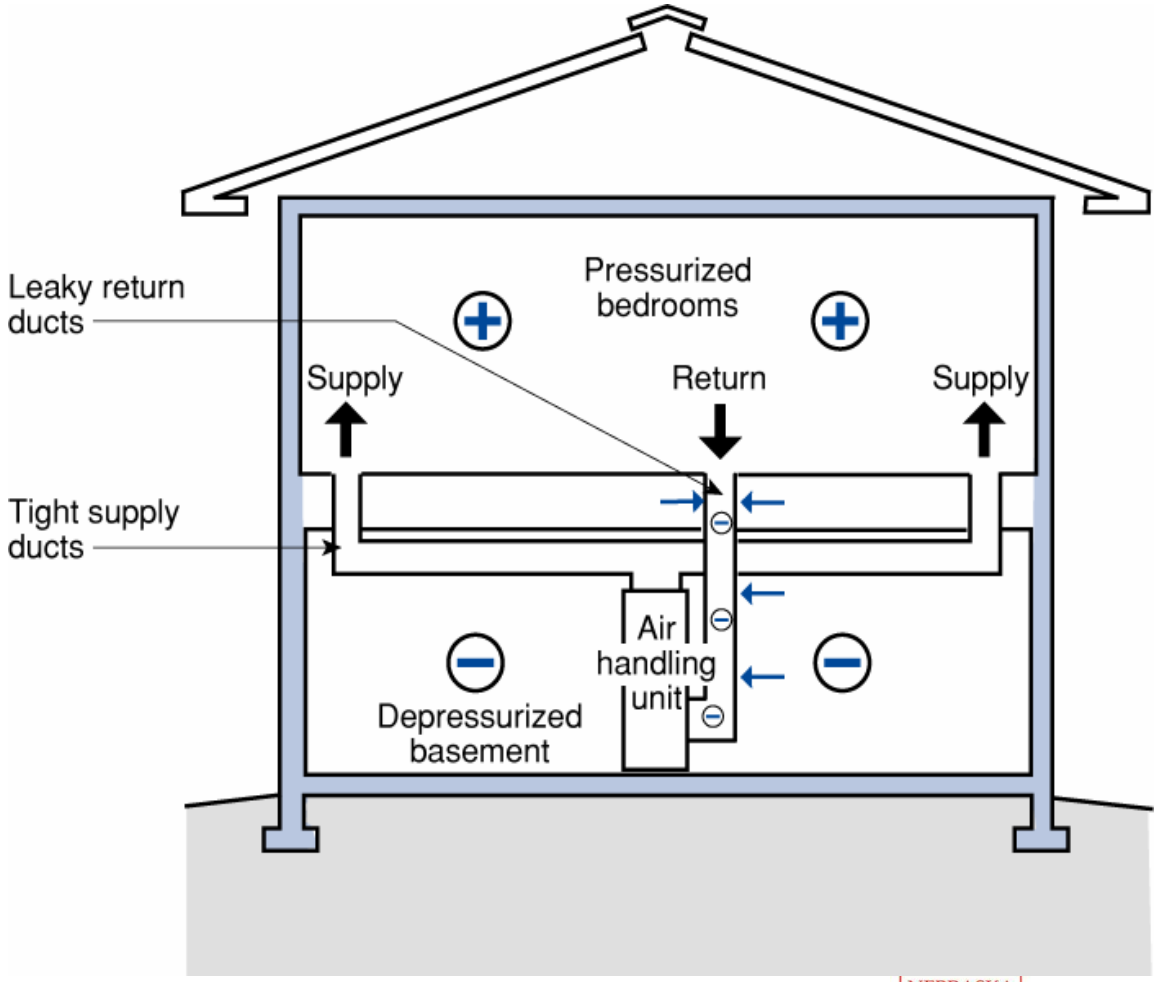
Wind



Stack Effect

Fans—Driving Forces for Infiltration

Device	CFM
Bath	
Range hood	
Downdraft hood	
"Commercial" Hood	
Dryer	
Air Handler	/ ton



Ventilation and Air Sealing

- Both natural and mechanical ventilation provide fresh air that can dilute and remove indoor pollutant levels
- Per the IMC/IRC, mechanical ventilation is required when homes are <5 ACH 50
  - Need to do a blower door test to determine leakage rate
  - **Liability concerns when not performed**
- A blower door test measures a building's existing air leakage
- Can not design a code compliant system without knowing air leakage

Courtesy of AC Tool Supply, Inc.

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Ventilation and Air Sealing

- Blower door test result can be in CFM.
- Converting to ACH determines building's need for mechanical ventilation (≤5 ACH50)

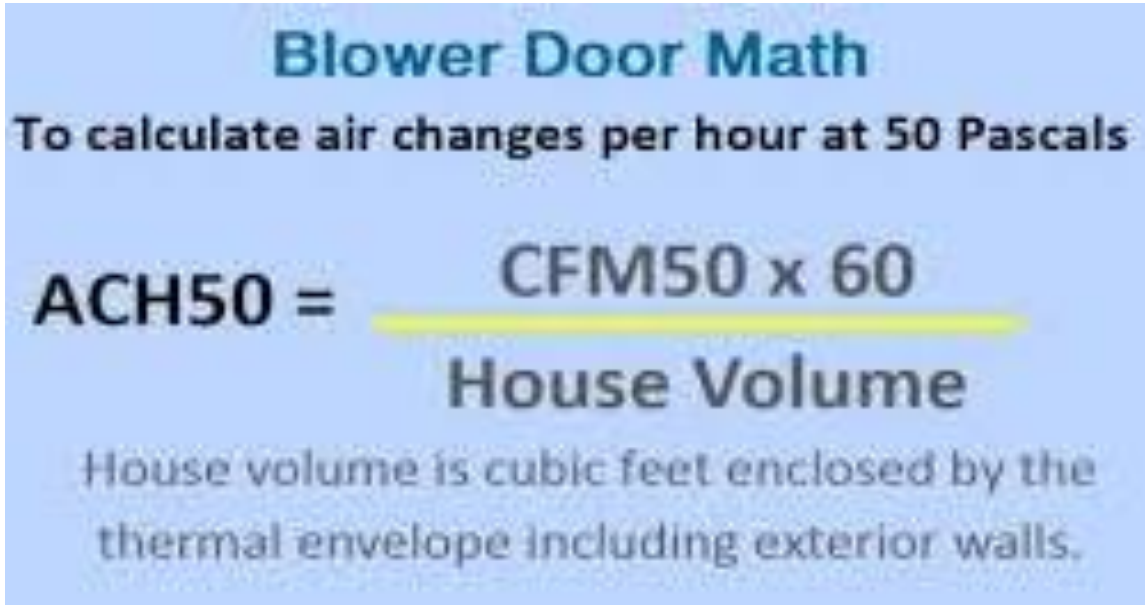

Image: deq.mt.gov

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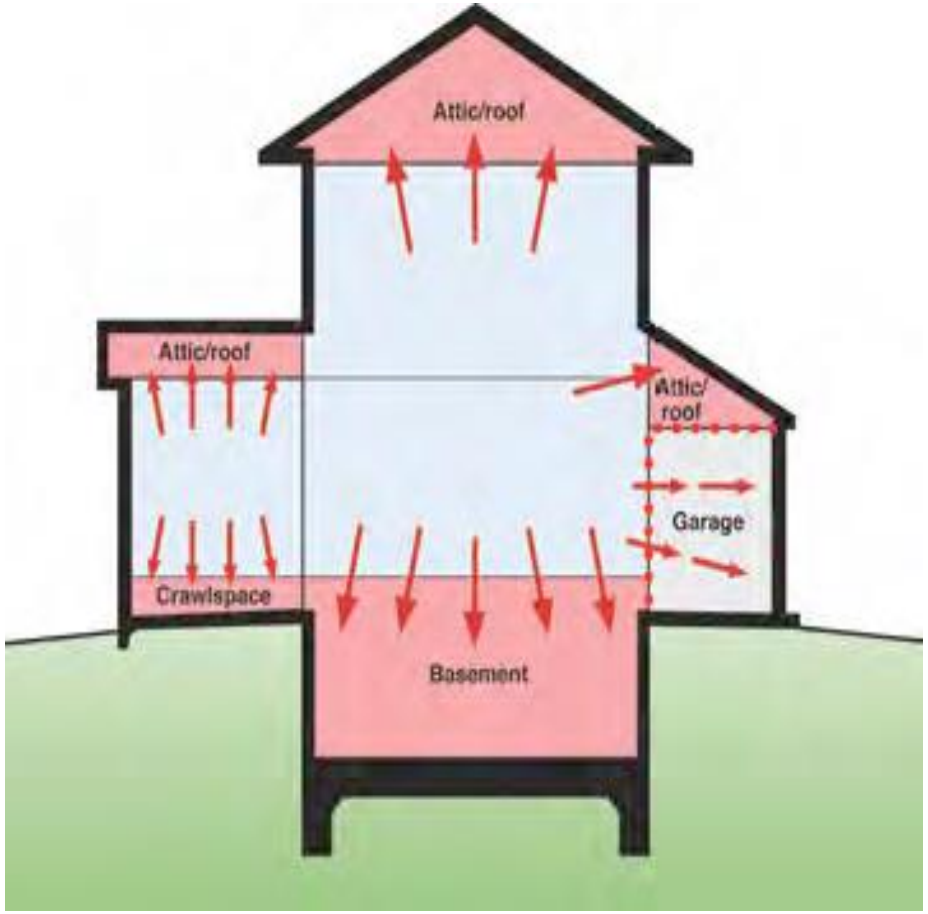
Ventilation – Pressure Differential



Expansion of Conditioned Space

- HVAC systems, temperature, wind, and stack effect all cause pressure differentials between inside and outside
- HVAC systems pressurize the home and conditioned space boundaries moving towards exterior surfaces of building
- Garage isolated from house by air barrier/pressure boundary
- Garage ventilated and conditioned independently of rest of conditioned spaces

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Considering HVAC Design and Loads

- Today's homes risk health problems from inadequate ventilation
- New construction materials and techniques result in tighter homes
  - Sometimes <1 ACH50
- In some jurisdictions blower door tests are not required so builders are unaware of the need for ventilation
- Average from NE Residential Baseline Study is a new home air leakage of 2.8 ACH50
- More chemicals and products are used in and around a house
  - Concentration levels can be 2 to 100 times higher than outside.

Image: conditionedairsolutions.com

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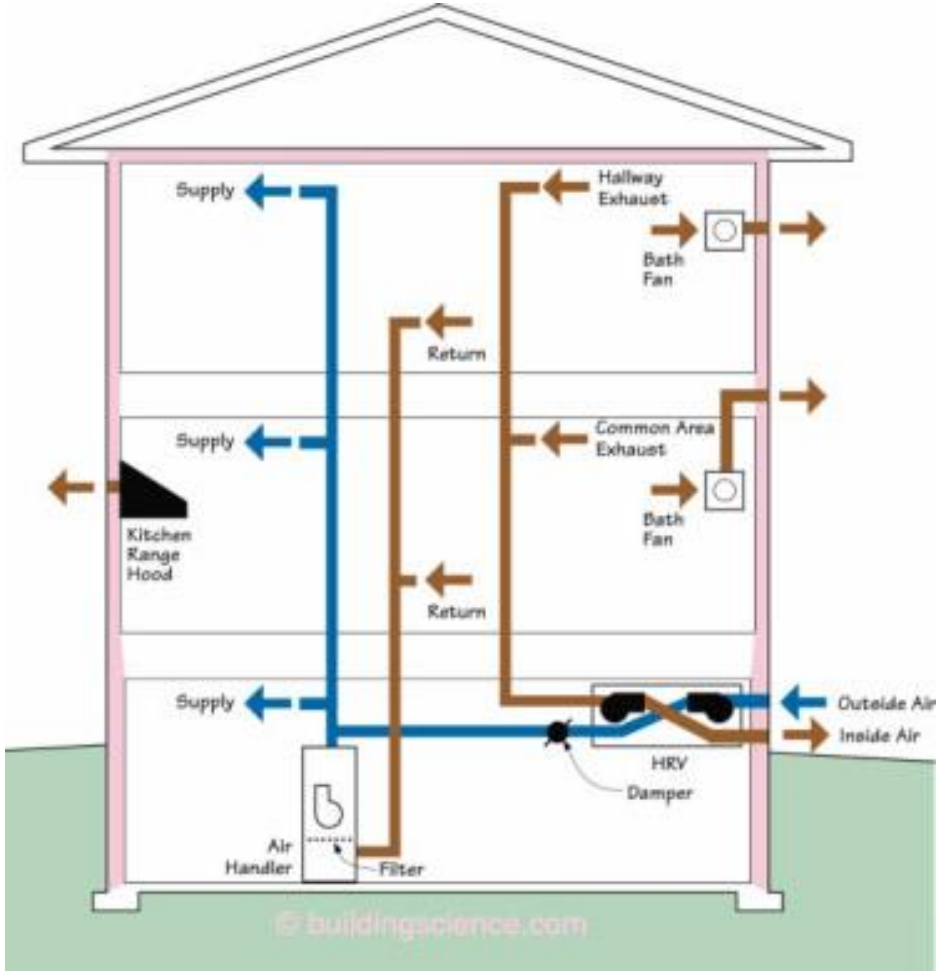
Balanced Ventilation



- Blows air into and out of the house
- ERV/HRV makes this cost effective by reclaiming energy from exhaust and supply airflows (60%-80%!)
- Balances exhaust and supply flows
- Maintains the Minimum Ventilation Guidelines automatically with proper set-up

Image: buildingscience.com

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Balanced Ventilation - HRV

A heat recovery ventilator (HRV) uses a heat exchanger to condition incoming fresh air:

- It consists of a cube-shaped transfer unit made from special conductive materials.
- Airflows pass through different sides of the cube (but are not mixed).
- Conditioned exhaust air raises or lowers the incoming fresh air temperature.
- Air passes through an HVAC air handler or directly to rooms.

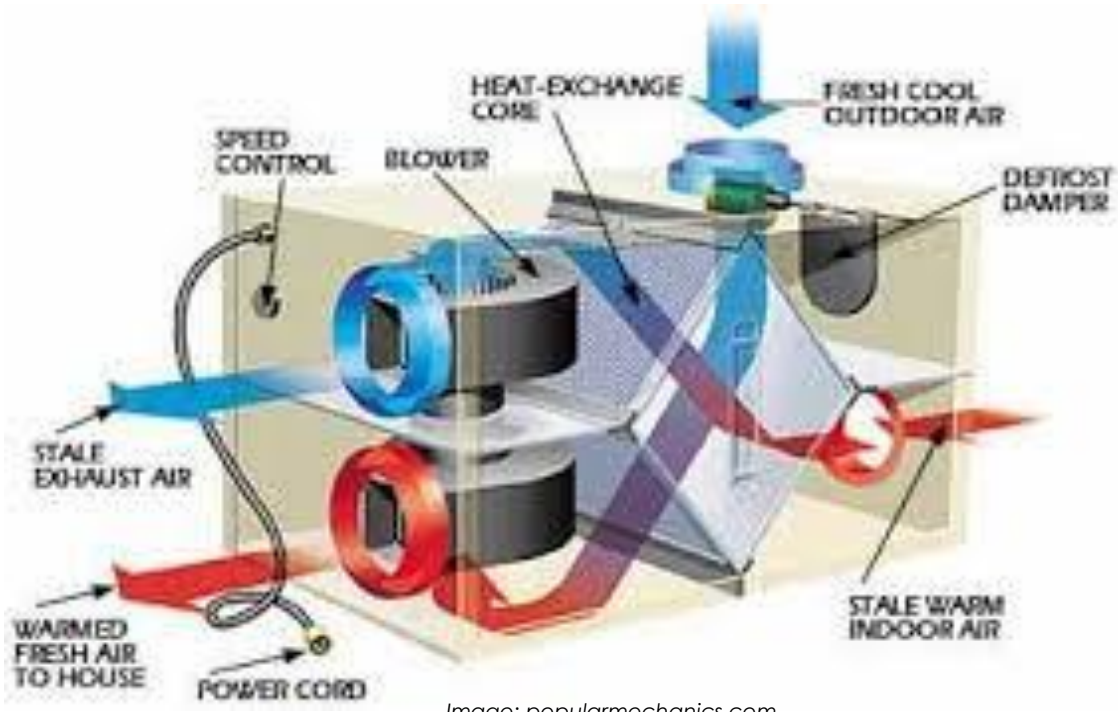

Image: popularmechanics.com

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Balanced Ventilation - ERV

An energy recovery ventilator (ERV) exchanges heat and moisture between the two air streams:

- It transfers moisture by a desiccant wheel.
- It allows the exchange of moisture to control humidity.
- It preconditions the incoming flow with return air ducts before it exits.
- It passes air through an HVAC air handler or directly to rooms.

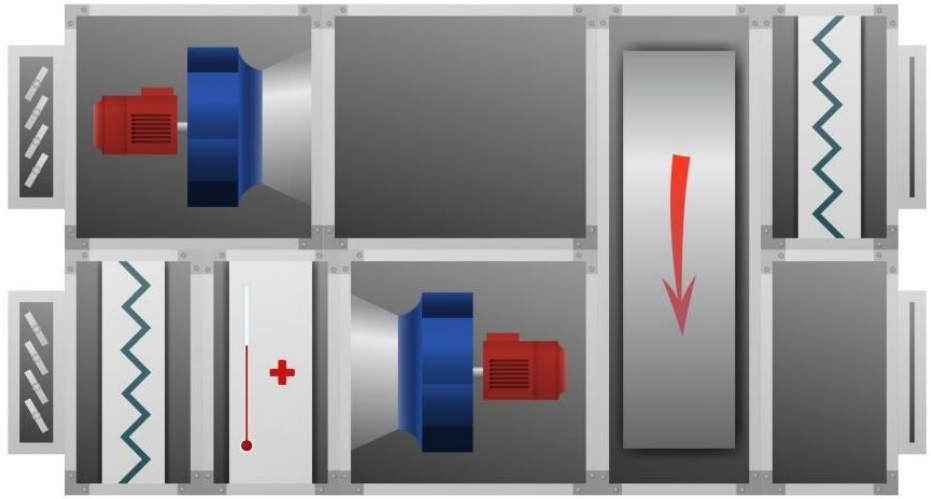

Image: totalcomfortma.com

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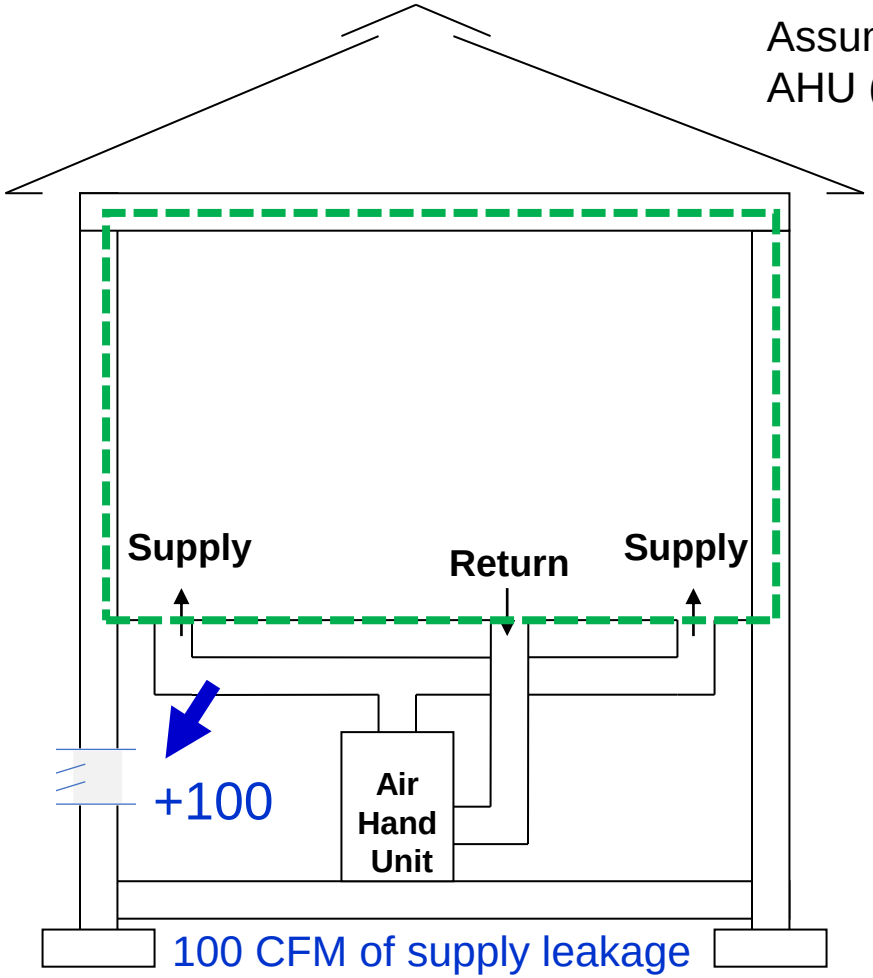
Duct Leakage—Driver for Infiltration

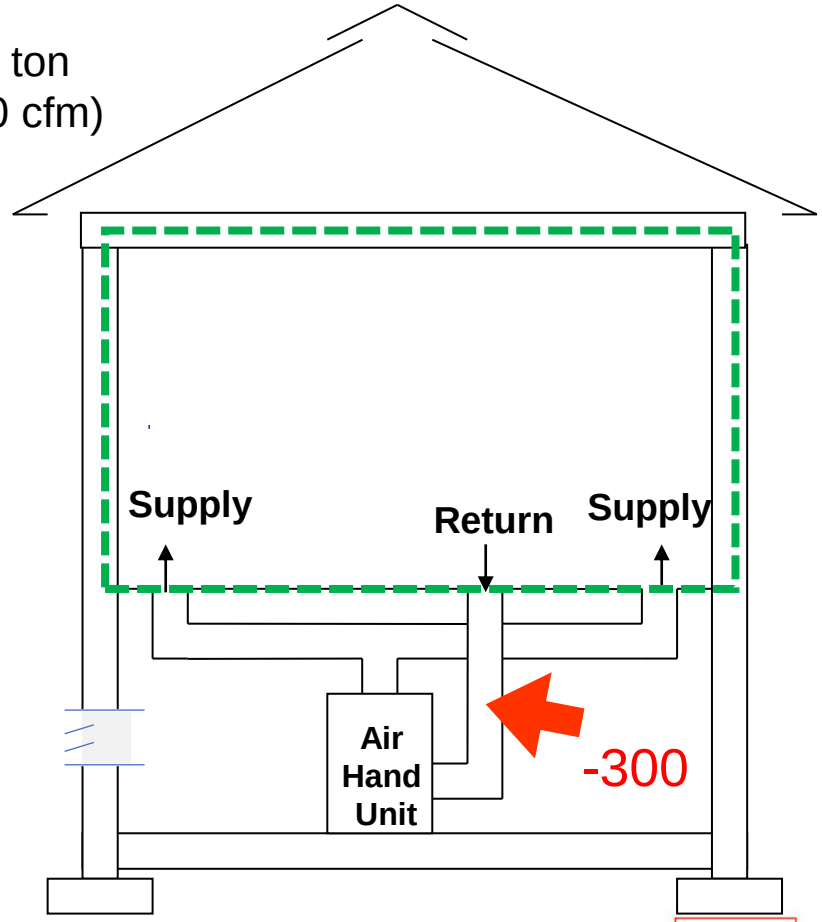
Effect on house pressure due to duct leakage

Assume 2.5 ton AHU (~1000 cfm)



100 CFM of supply leakage

Supply leaks cause house to _____



300 CFM of leakage into return

Return leaks cause house to _____

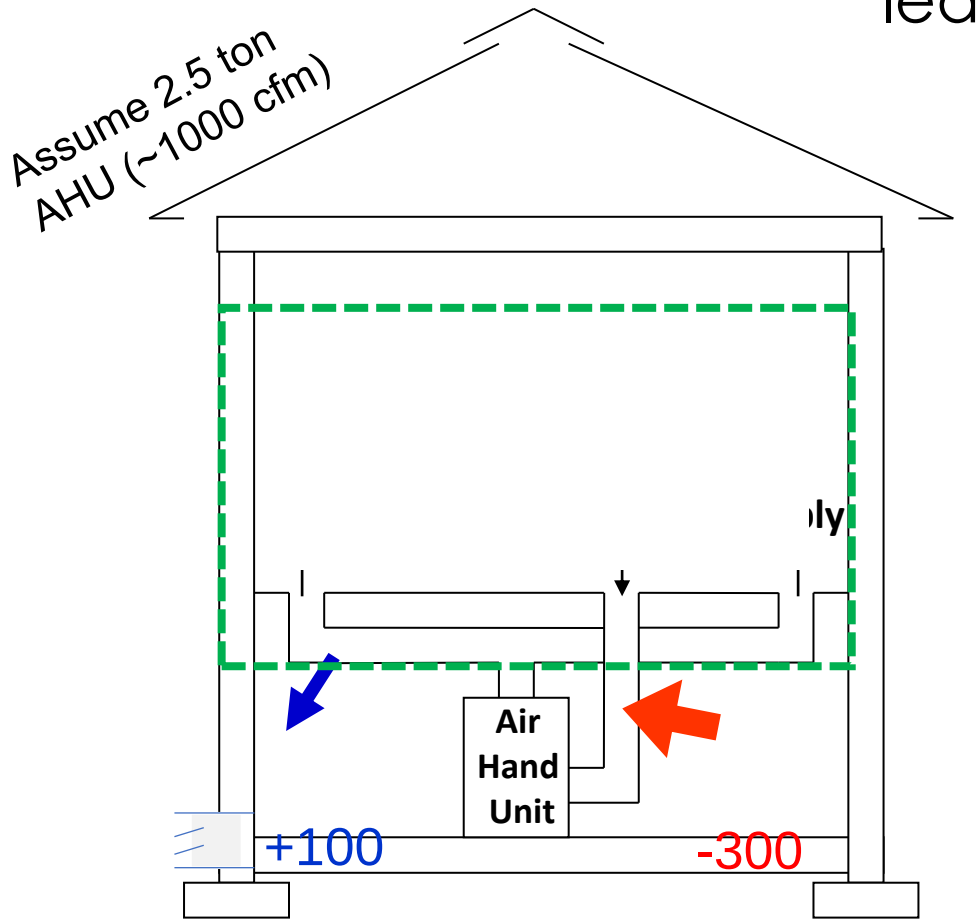
Duct Leakage—Driver for Infiltration

Effect on house pressure due to duct leakage

Dominant

Duct Leakage

What is the net effect on House Pressure to Outside due to:
100 cfm of supply &
300 cfm of return duct leakage?



100 CFM of leaks in supply &
300 CFM of leaks in return

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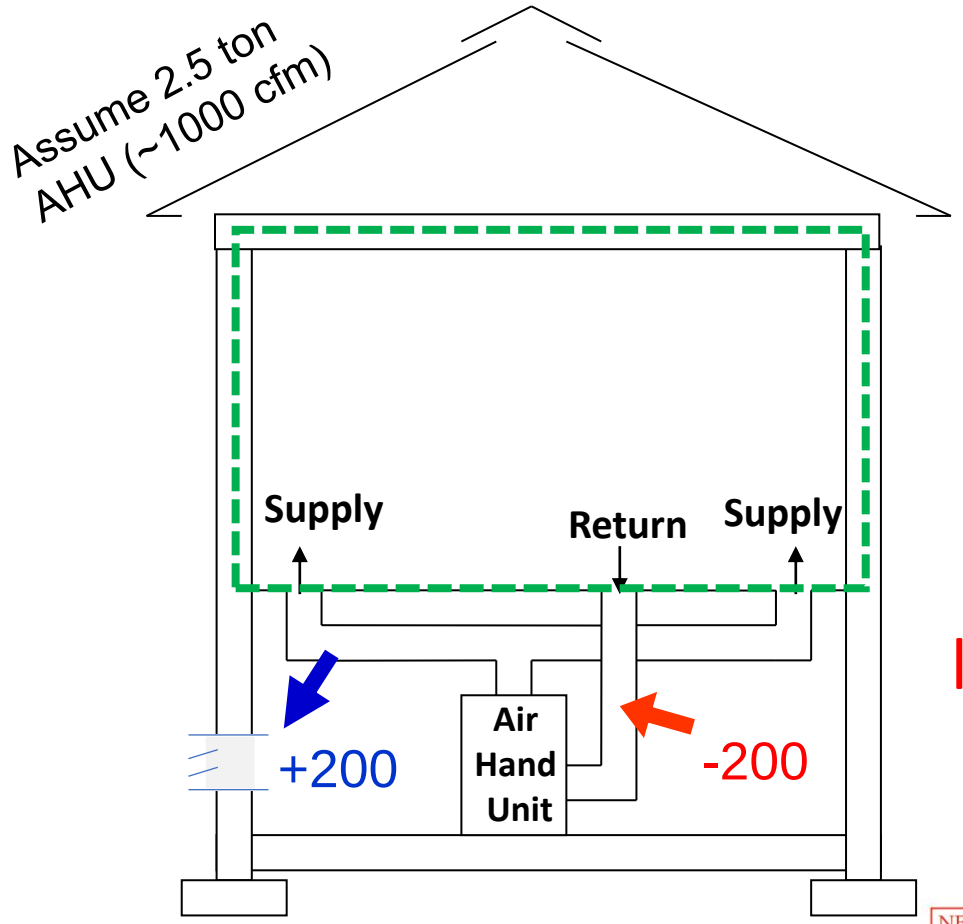
Duct Leakage—Driver for Infiltration

Effect on house pressure due to duct leakage

Equivalent Duct Leakage

What is the net effect on House Pressure to Outside due to:
200 cfm of supply &
200 cfm of return duct leakage?



200 CFM of leaks in supply &
200 CFM of leaks in return

AIR SEALING & INSULATION

TABLE R402.4.1.1 AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION[a]

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
General requirements	A continuous air barrier shall be installed in the building envelope. 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 or 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, *R*-value, of not less than R-3 per inch. 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 framing and skylights, and the jambs of windows and doors, shall be sealed.	—
Rim joists	Rim joists shall include an exterior air barrier.[b] The junctions of the rim board to the sill plate and the rim board and the subfloor shall be air sealed.	Rim joists shall be insulated so that the insulation maintains permanent contact with the exterior rim board.[b]
Floors, including cantilevered floors and floors above garages	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. Alternatively, floor framing cavity insulation shall be in contact with the top side of sheathing, or continuous insulation installed on the underside of floor framing and extending from the bottom to the top of all perimeter floor framing members.
Basement crawl space and slab foundations	Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder/air barrier in accordance with Section R402.2.10. Penetrations through concrete foundation walls and slabs shall be air sealed. Class 1 vapor retarders shall not be used as an air barrier on below-grade walls and shall be installed in accordance with Section R702.7 of the *International Residential Code*.	Crawl space insulation, where provided instead of floor insulation, shall be installed in accordance with Section R402.2.10. Conditioned basement foundation wall insulation shall be installed in accordance with Section R402.2.8.1. Slab-on-grade floor insulation shall be installed in accordance with Section R402.2.10.
Shafts, penetrations	Duct and flue shafts to exterior or unconditioned space shall be sealed. Utility penetrations of the air barrier shall be caulked, gasketed or otherwise sealed and shall allow for expansion, contraction of materials and mechanical vibration.	Insulation shall be fitted tightly around utilities passing through shafts and penetrations in the building thermal envelope to maintain required *R*-value.
Narrow cavities	Narrow cavities of 1 inch or less that are not able to be insulated shall be air sealed.	Batts to be installed in narrow cavities shall be cut to fit or narrow cavities shall be filled with insulation that on installation readily conforms to the available cavity space.
Garage separation	Air sealing shall be provided between the garage and conditioned spaces.	Insulated portions of the garage separation assembly shall be installed in accordance with Sections R303 and R402.2.7.
Recessed lighting	Recessed light fixtures installed in the building thermal envelope shall be air sealed in accordance with Section R402.4.5.	Recessed light fixtures installed in the building thermal envelope shall be airtight and IC rated, and shall be buried or surrounded with insulation.
Plumbing, wiring or other obstructions	All holes created by wiring, plumbing or other obstructions in the air barrier assembly shall be air sealed.	Insulation shall be installed to fill the available space and surround wiring, plumbing, or other obstructions, unless the required *R*-value can be met by installing insulation and air barrier systems completely to the exterior side of the obstructions.
Shower/tub on exterior wall	The air barrier installed at exterior walls adjacent to showers and tubs shall separate the wall from the shower or tub.	Exterior walls adjacent to showers and tubs shall be insulated.
Electrical/phone box on exterior walls	The air barrier shall be installed behind electrical and communication boxes. Alternatively, air-sealed boxes shall be installed.	—
HVAC register boots	HVAC supply and return register boots that penetrate building thermal envelope shall be sealed to the subfloor, wall covering or ceiling penetrated by the boot.	—
Concealed sprinklers	Where 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.	—

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Performance Testing

Diagnostic/Verification Tools

Blower Door

Duct Leakage Tester

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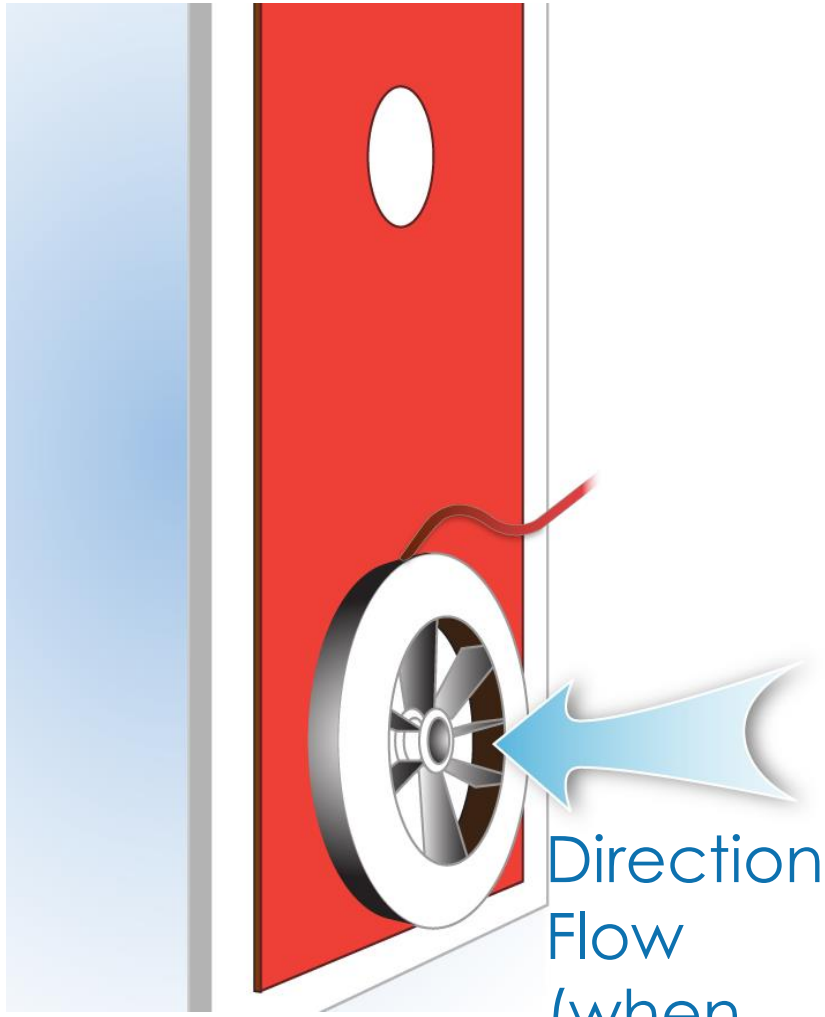
How a Blower Door Works



Direction of Air Flow (when depressurizing)

- Air flow across the sensor in the hub of the fan causes a pressure difference with reference to (WRT) to the *inlet side of the fan*
- The manometer measures the fan pressure difference compared to the *fan inlet side* (the house when depressurizing, the outside when pressurizing)
- The fan pressure difference is recorded and the flow (CFM) is looked up from a chart *OR* the gauge can be programmed to convert the fan pressure difference to a flow (CFM)

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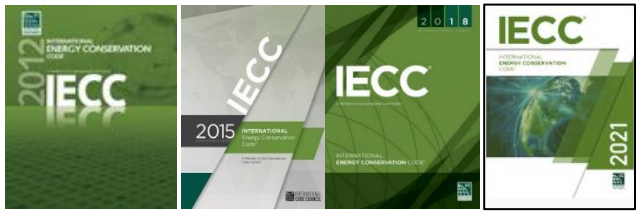
Blower door envelope testing



- Required by IECC 2012 onward
- Homes must be < 3 or < 5 ACH_{50}

$$ACH_{50} = \frac{CFM_{50} \times 60}{Volume}$$

- Quantifies the Amount of Leakage Across the Home's Thermal Boundary
- Test Performed by a Certified Professional (DET Verifier)
- Reported to Builder and Code Official via Certificate

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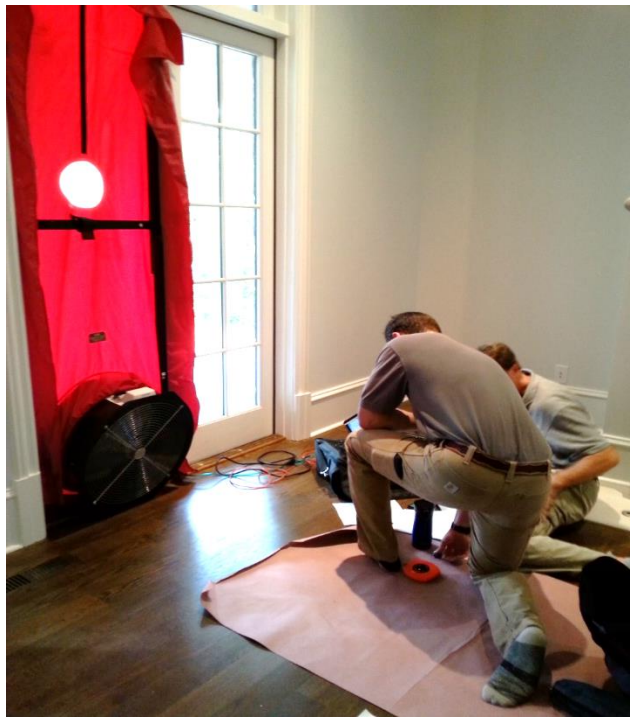
Prescriptive envelope BD testing thresholds

- Prescriptively, the home in Climate Zones 3-8 must be
  $< 3\ ACH_{50}$

$$ACH_{50} = \frac{CFM_{50} \times 60}{Volume}$$

- Alternately, small Homes < 1500 s.f. and attached MF homes may comply with
  $ELR_{50} < 0.30$

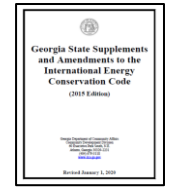
$$ELR_{50} = \frac{CFM_{50}}{Shell\ Area}$$



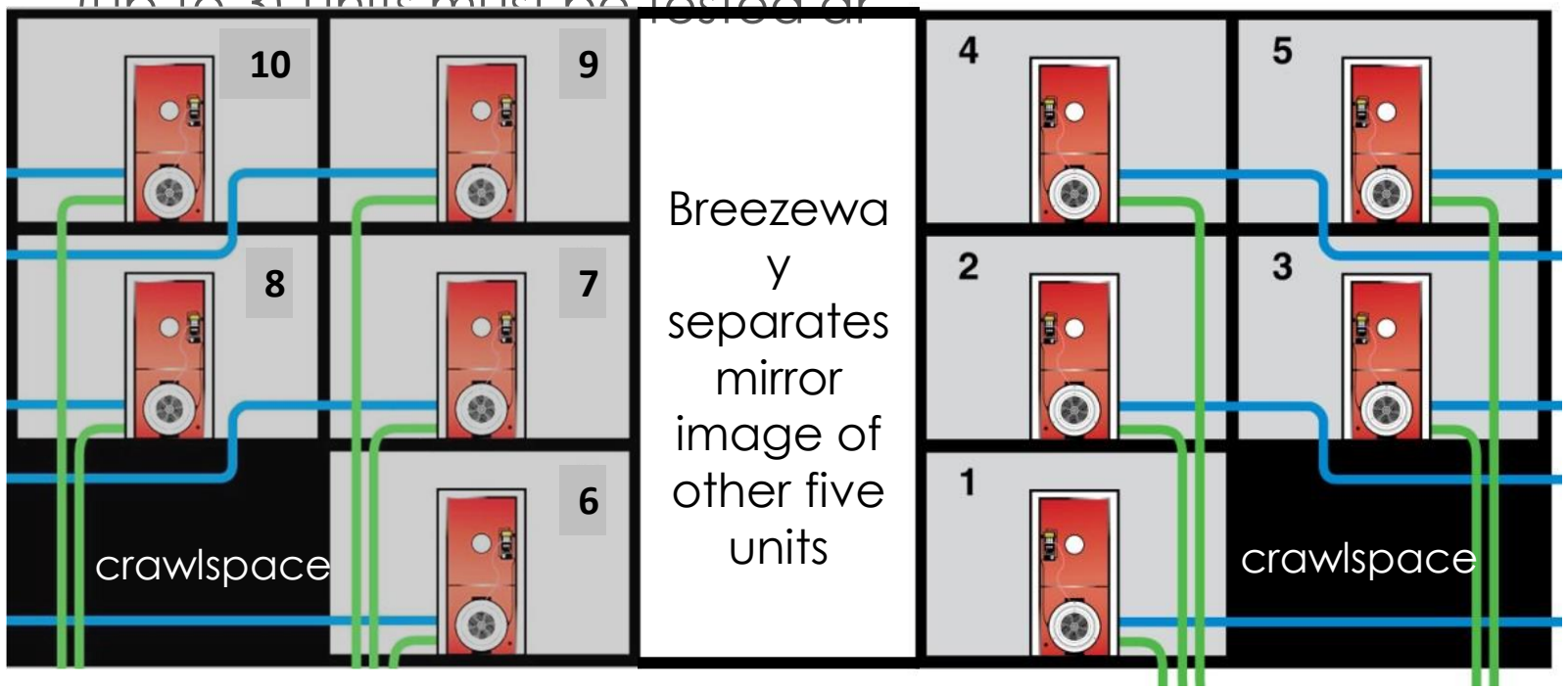
Exception: When testing individual *dwelling units*, an air leakage rate not exceeding 0.30 cubic feet per minute per square foot [0.008 $m^3/(s \times m^2)$] of the dwelling unit enclosure area, tested in accordance with ANSI/RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pa), shall be permitted in all climate zones for:

1. Attached single and multiple-family building *dwelling units*.
2. Buildings or *dwelling units* that are 1,500 square feet (139.4 m^2) or smaller.

MULTIFAMILY BLOWER DOOR SAMPLING OPTION



- 1 unit in (up to) 4 per floor is tested – if it **passes**, remaining (up to 3) units pass
- If sampled unit **fails**, it must be sealed and retested and remaining (up to 3) units must be tested as



For example, units #6, 8 and 5 are tested

- If 6 passes, so does 1
- If 8 passes, so do 7, 2 and 3
- If 5 passes, so do 4, 9 and 10

Blower Door Testing

- Can be performed at final inspection or earlier in construction process
- Depressurizes the home to identify areas of leakage
- Leakage calculated in ACH50
  - Indicates how many times the volume of air that is inside the building changes with the outside air under test conditions
  - 3 ACH50 or lower required by model code

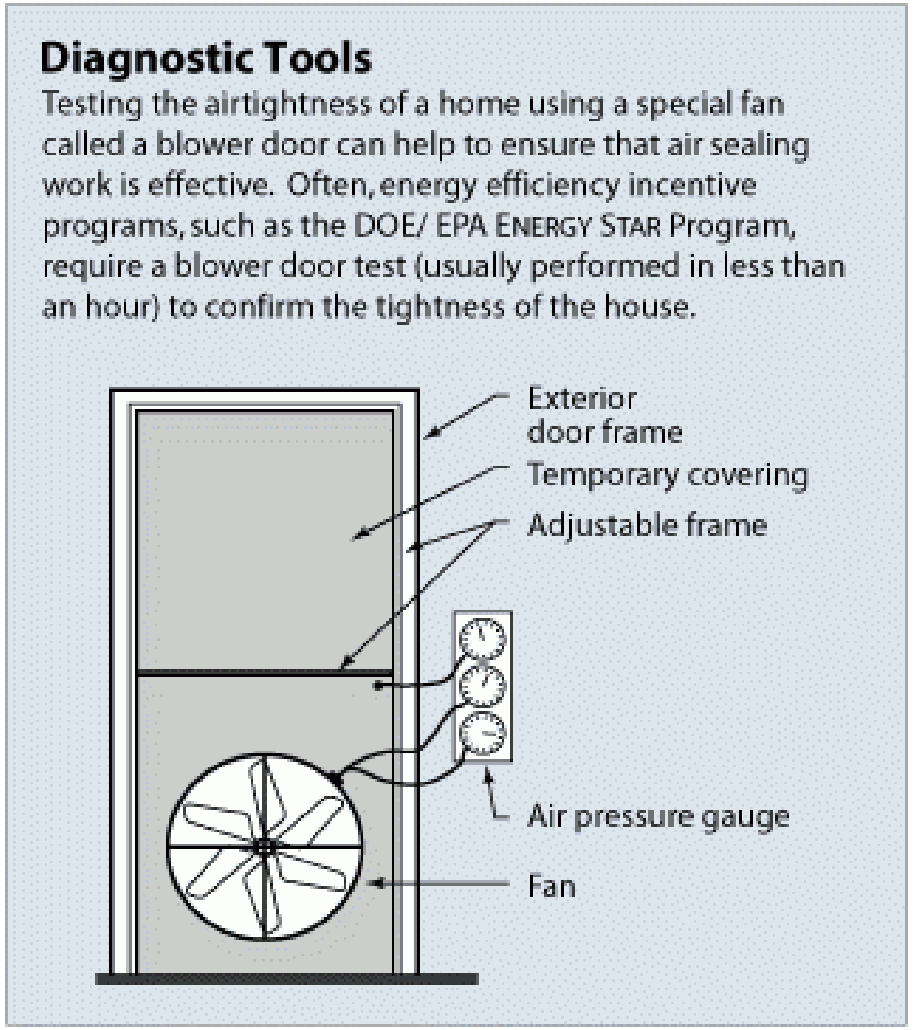


Image: U.S. DOE

Benefits of Blower Door Testing

- Documents and quantifies home's air leakage
- Third party verification (some areas; performed by Inspectors)
- Not required in Lincoln's Energy Code (but still a really good idea!)
  - Provides data needed for understanding ventilation needs, final equipment adjustment and energy use/cost forecast
  - Great liability protection for all involved
  - Improved Home Performance

Image: Green Building Advisor

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Approximate Leakage Area

Approximate hole size is a great way to describe what CFM_{50} really means

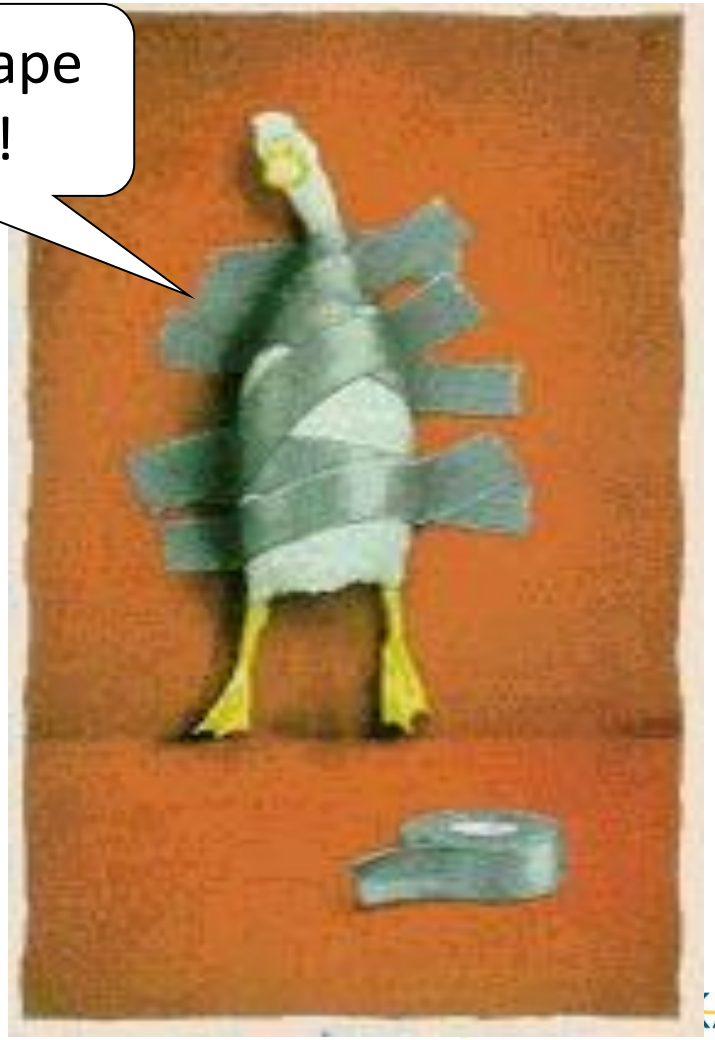
Divide CFM_{50} by 7.495

- *For example:*

  4,247 CFM_{50} / 7.495
  = **<u>567 sq. in.</u>**
- **Divide by 144 to get ~<u>4 s.f.</u>**

Testing Duct Leaks

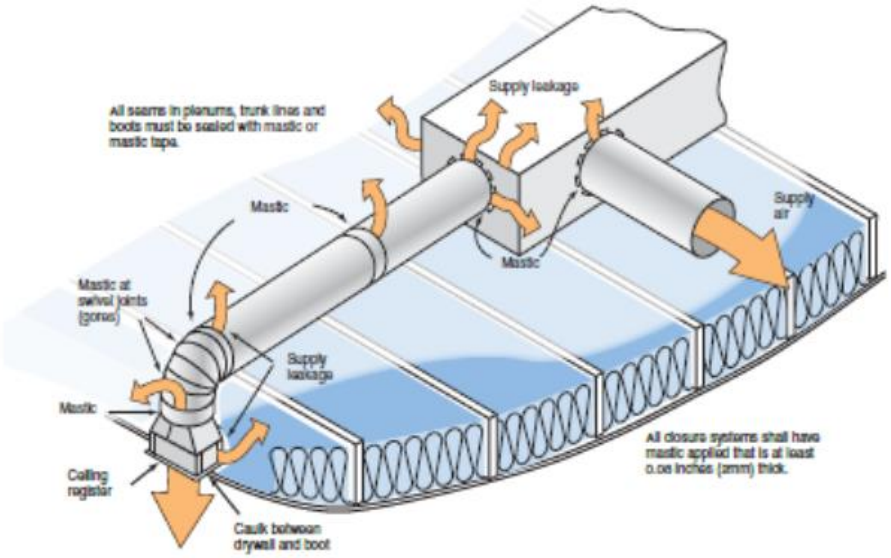
Don’t use tape on ducts!

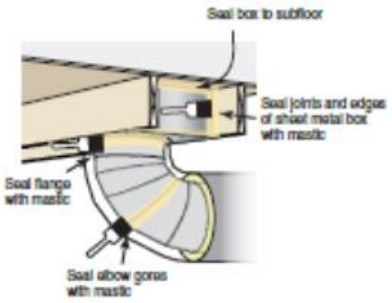


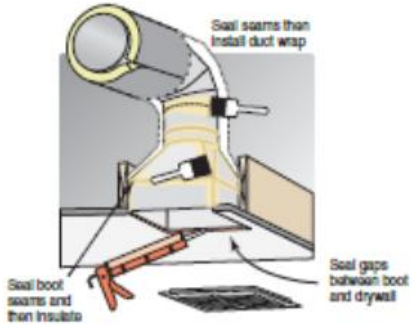
Duct Sealing

Appendix RA
2015 IECC (2019 Georgia Energy Code)

Duct Sealing key points

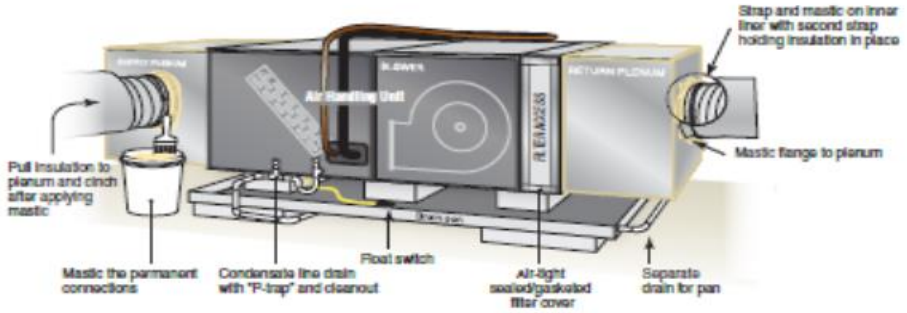


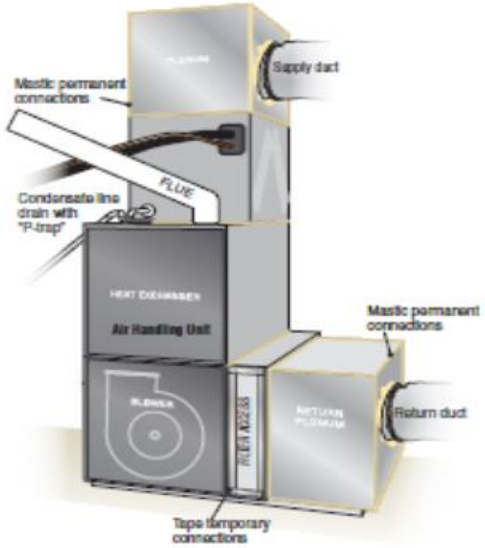


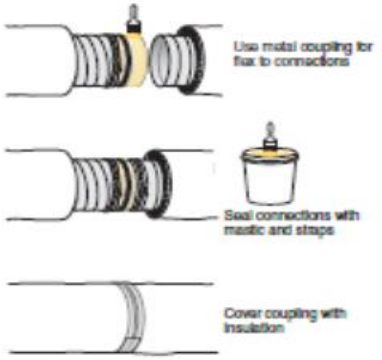


Appendix RA
2015 IECC (2019 Georgia Energy Code)

Air Handler Sealing key points







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Duct Testing Requirements 2009-2018

- Duct systems must be leak tested
  - When tested at rough-in
    - 4% Total leakage no AHU installed
      (**RITnah** Rough-in Total Leakage, no air handler)
      (not permitted in GA)
    - 6% Total leakage w/ AHU
      (**RIT** Rough-in Total Leakage)
  - When tested at final
    - 12% Total Leakage
      (**PCT** Post-Construction Total Leakage)
    - 8% Leakage to Outside
      (**PCO** Post-Construction Leakage to Outside)

**Exception: Duct tightness test is not required if the air handler and all ducts are located within conditioned space*

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What's different about 2012/15/18 IECC?

- Duct testing is required*
  - When tested at rough-in
    - 3% Total leakage no AHU installed (**RITnah** Rough-In Total Leakage, no air handler)
    - 4% Total leakage w/ AHU (**RIT** Rough-In Total Leakage)
  - When tested at final
    - 4% Total Leakage (**PCT** Post-Construction Total Leakage)

***Exception**: Duct tightness test is not required if the air handler and all ducts are located within conditioned space*

*

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Biggest Changes in IECC 2021

- Redrawn Climate Zones (No Change in NE)
- Improved Window U-factors & Wall and Ceiling R-values
- Attic pull-down stairs – R-13 okay for CZ1-4
- Floor insulation – 3 options
- Basement option details
- Sunrooms and heated garage separation
- Ducts Testing on all systems
- Ducts inside, < 8% Total Leakage
- Ducts outside, < 4% Total Leakage
- Verified fan (kitchen, bath, whole house) airflow
- All efficient lighting and controls (100%)
- Must choose your Additional Efficiency Package

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What's different about 2021 IECC?

- Duct testing is required for all systems
  - When tested at rough-in
    - 4% Total leakage*
      (**RIT** Rough-In Total Leakage) (*__3%__ without air handler, **RITnah**)
  - When tested at final – ducts outside envelope
    - 4% Total Leakage
      (**PCT** Post-Construction Total Leakage)
  - When ducts are inside envelope**
    - 8% Total Leakage –
      (**PCT** Post-Construction Total Leakage)

Note: Blower Door and Duct Leakage test results must be displayed on Certificate!

*****Duct tightness test is now required even if the air handler and all ducts are located within conditioned space!!!!!***

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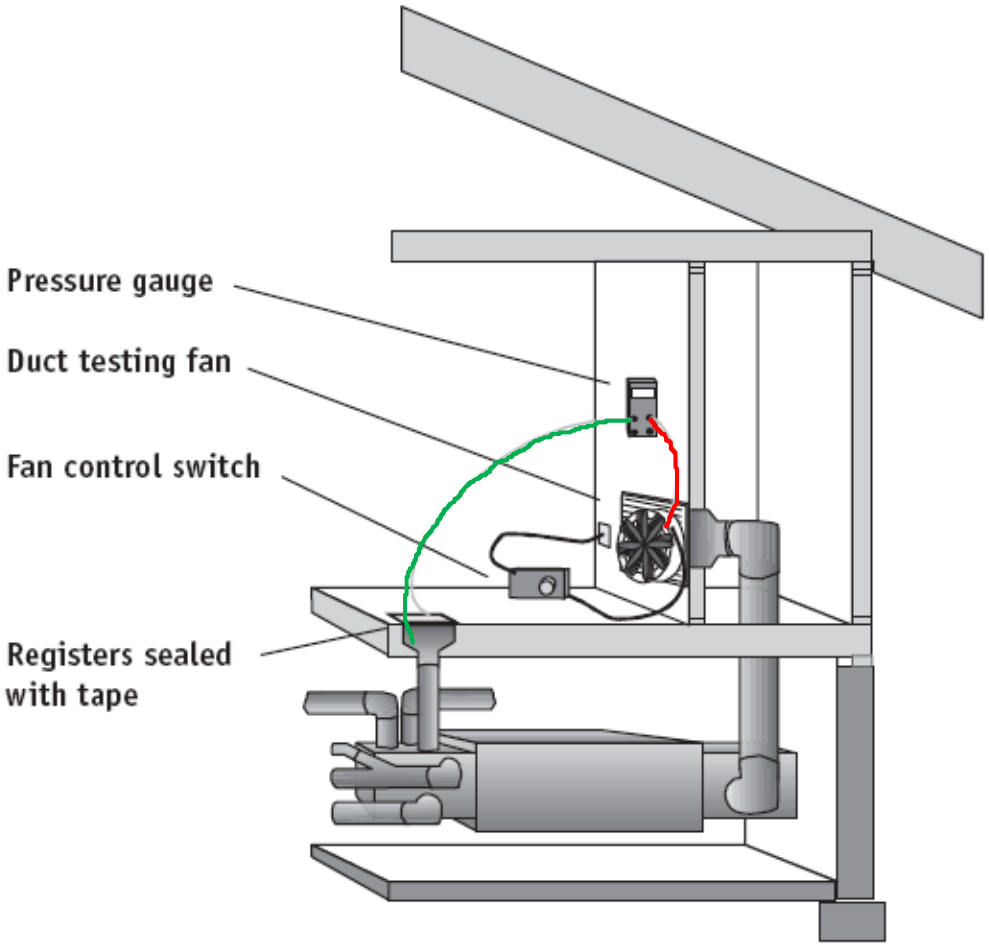
Duct pressure test finds leaks and estimates air flow in cfm

Pressurizing the system; connected at the largest return

Depressurizing the system; connected at the air handling unit

Duct Testing Basics



Allow the air to flow freely from the fan to the duct system

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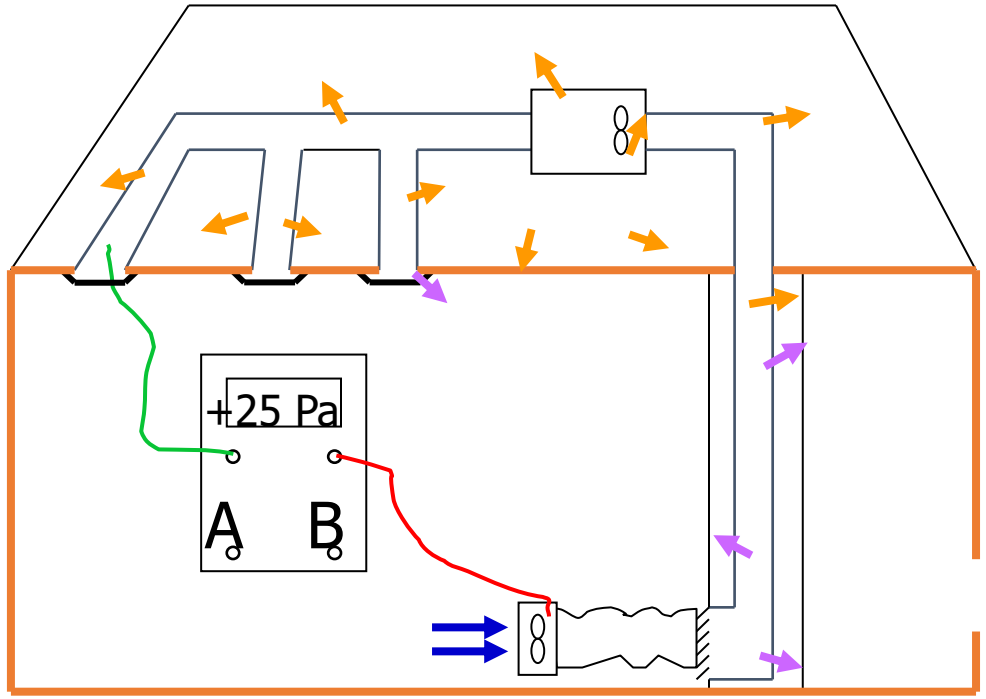
Duct Test—"Total Leakage"

Note: This test could be performed at rough-in (**RIT**) stage OR at final (**PCT**)

1. Open a door so house = outside pressure
2. Use duct tester to pressurize duct system to +25 Pa WRT outside
3. Record fan flow (channel B) in CFM_{25}
   (when programming gauge, set MODE as "PR/FL@25")



Ring 2, Fan Press=90 Pa

Flow is 150 cfm_{25}

Discuss issue of Residential Ventilation

- In 2012 IECC: Single Family must be < 5 ACH_{50} to pass Energy Code in all CZ's
- 2012 IRC: If < 5 ACH_{50}, must provide whole-house mechanical ventilation system

- In 2021 IECC: All homes must be < 5 ACH_{50} and must provide whole-house mechanical ventilation system to satisfy IRC
- Testing of ventilation system to verify airflow is required

For a ventilation white paper with more information on residential ventilation, visit www.southface.org /resources/georgia-energy-code-resources/

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DET Verifier Resources

- Refresher videos about blower door testing (~10 minutes each)
- 10-minute YouTube BD video: Search “Southface Blower”
- https://www.youtube.com/watch?v=ObrAHxe2FLk&t=293s

http://wxtvonline.org (blower door basics)

- 10-minute YouTube DB video: Search “Southface Duct”
- https://www.youtube.com/watch?v=FS1P1kfPMYY

Three companies that sell equipment *(ask about discounts)*
- Energy Conservatory
- Retrotec
- Infiltec

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Questions?

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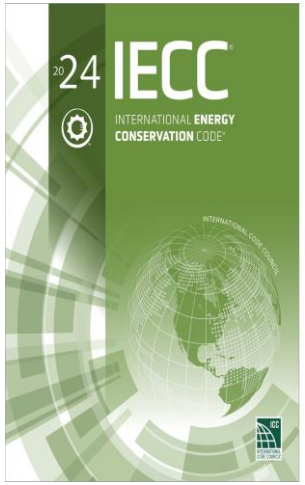
2024 National Energy Standard:

- *More* focus on Electrification
- Tables for Envelope and Fenestrations (402/403)updated
- More reliance of high performance
- More focus on testing/verification
- More intent to move appendices items forward in 2027 & 2030 versions



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Upcoming Events:

May

5/21/24: Nebraska Collaborative Meeting – **NDEE Lincoln**

June

6/5/24: ResCheck Training

July

7/17/24: ComCheck Training

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Thank you!

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