The Residential Building Envelope

Instructor: Matt Belcher

January 11, 2022

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

Today's Agenda

- Current Building Practices in Nebraska
- Building Thermal Envelope and the 2018 IECC
- Air Sealing Principles and Priorities
- Ventilation
- Performance Testing
- Q&A

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

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/AIA)
- Email nwestfall@mwalliance.org with questions

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

Introduction Poll #1

- What is your profession?
  - Code Official
  - Home Builder
  - State/local government
  - Energy Rater/Consultant
  - Architect/Engineer
  - Non-profit
  - Academic
  - Utility
  - Other (type in chat)

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

Introduction Poll #2

- How long have you been in the construction industry?
  - 0-5 years
  - 5-10 years
  - 11-15 years
  - 16-20 years
  - 21+ years

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

Introduction Poll #3

- How familiar are you with the residential provisions in the 2018 IECC?
  - Extremely Familiar
  - Somewhat Familiar
  - Somewhat Unfamiliar
  - Not familiar at all

Current Building Practices in Nebraska

Nebraska Residential Field Study

- Conducted in 2017 by **Nebraska Department of Environment and Energy** 2009 IECC was the baseline.

- Collected and analyzed several data points for new homes, including:
  - Envelope air leakage
  - Efficacy in lighting
  - Duct leakage
  - Ceiling & exterior wall insulation
  - Basement & slab insulation
  - Windows

For More Information and Data:

https://www.energycodes.gov/sites/default/files/documents/Nebraska_Residential_Compliance_Evaluation_final.pdf

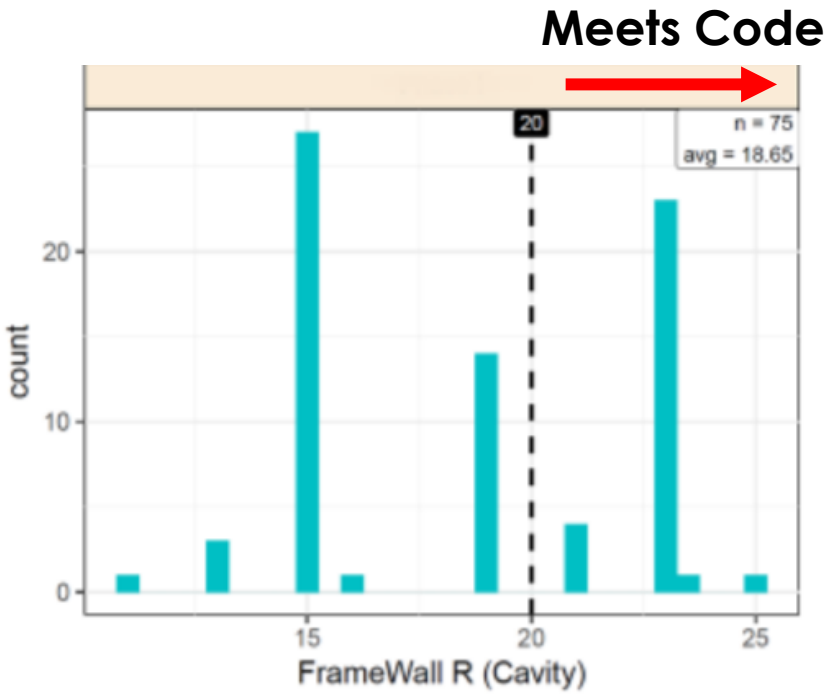
MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

Residential Field Study - Results

- **Frame Wall Insulation**: Most common installation was below code
  - Even continuous insulation < Code
  - **Quality of Installation an issue**
- **Basement Insulation**: Meets code(average), but room to improve
- **Slab insulation**: Meets or exceeds code
- **Windows**: Meets code but will need to upgrade to meet 2018 IECC



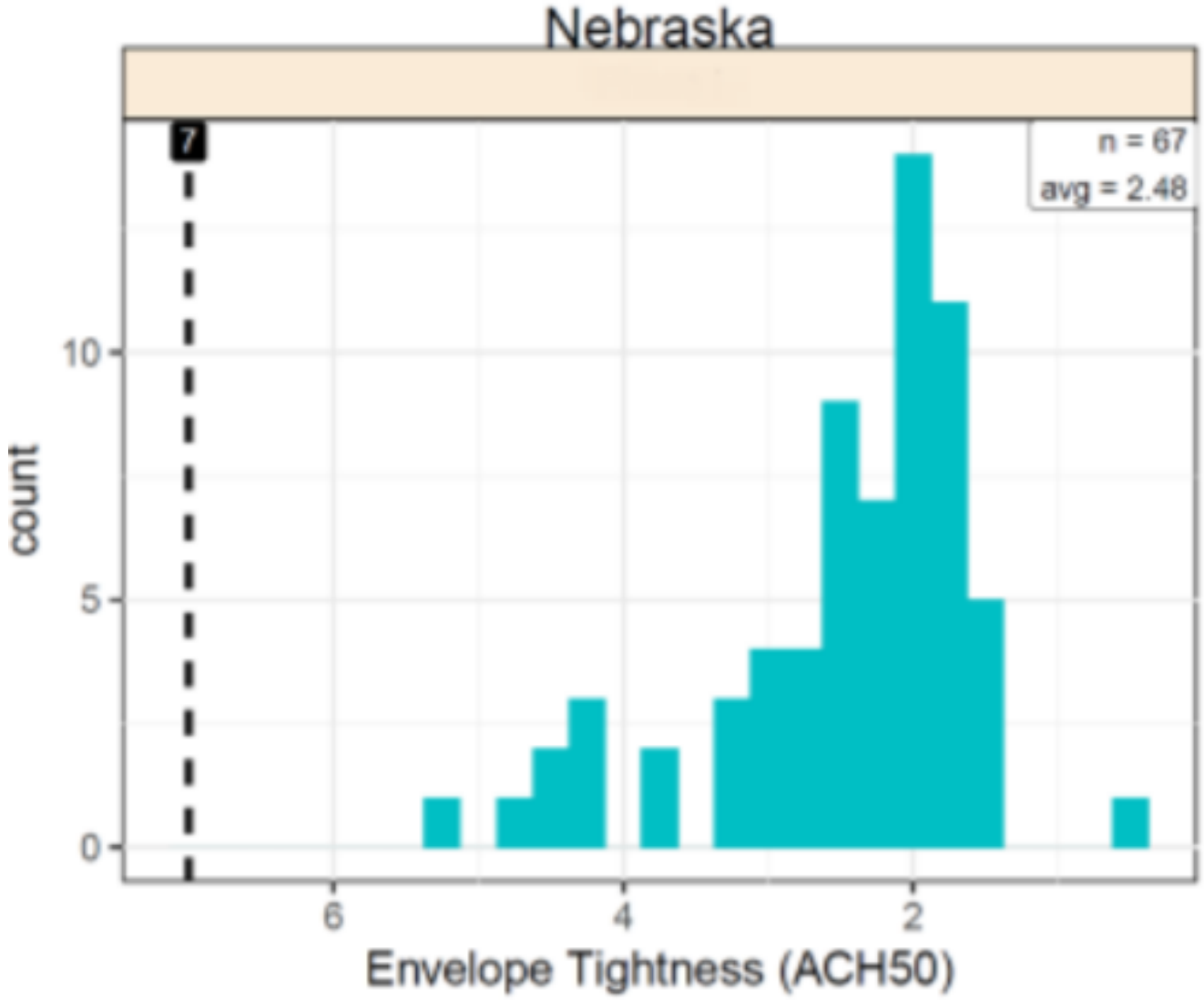
MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

Residential Field Study - Results

- **Envelope Air Leakage**: Better than code(7 ACH50)
  - Not all would meet 2018 IECC



MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

Building Thermal Envelope and the 2018 IECC

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

Building Thermal Envelope

- A well-designed building envelope promotes energy conservation through proper placement and appropriate use of materials for effective:
  - Air barrier
  - Insulation
  - Moisture control
  - Windows, doors and skylights

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

Air Barrier

- Air movement leads to both **energy loss and moisture transmission**.
- An **integrated air barrier prevents air movement** through the insulation and must be continuous and contiguous with the insulation.
- Air barrier must be **continuous** across walls, ceilings, and floors.
  - You should be able to trace the air barrier in a building cross section and never lift your pencil!

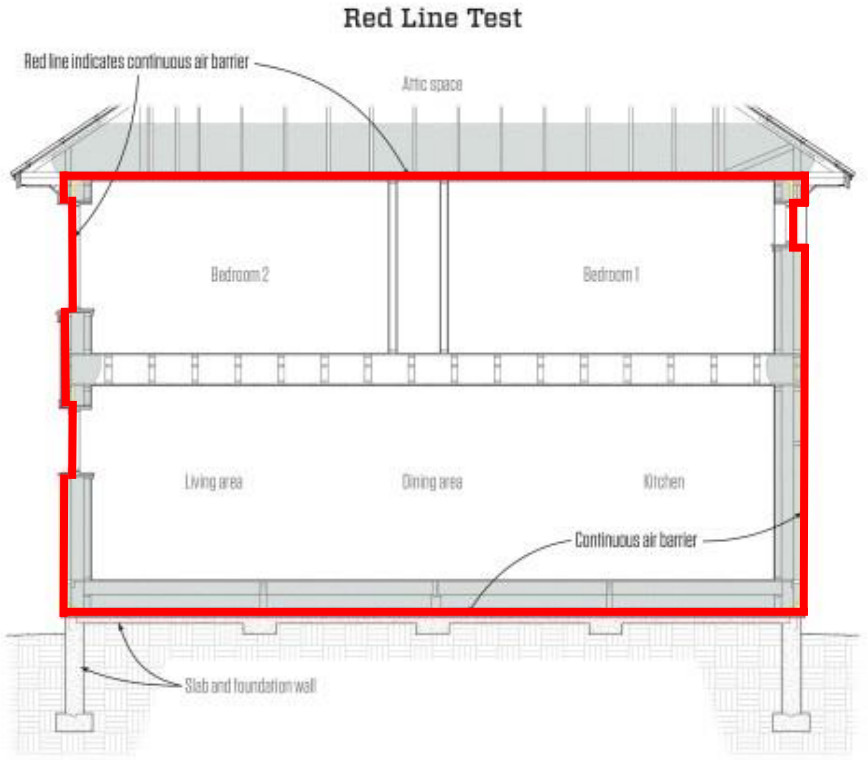


Image: jlconline.com

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

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

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

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

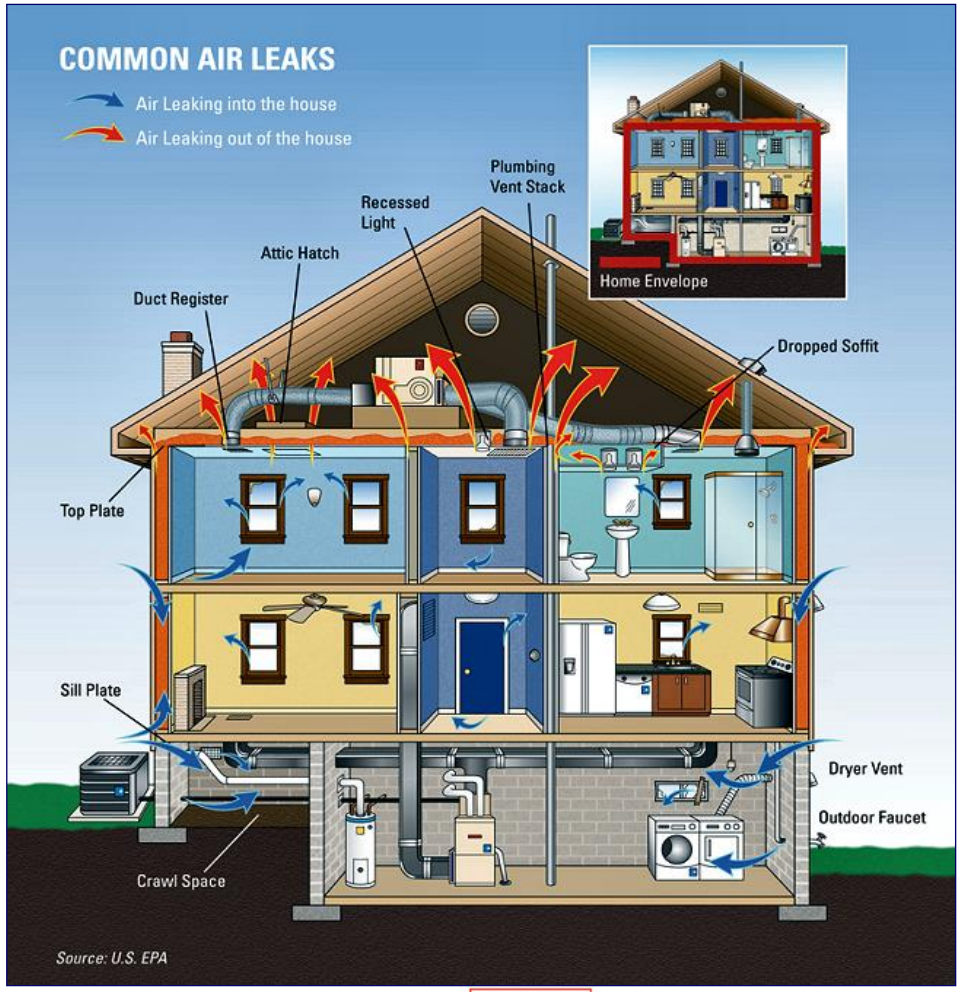


Image: epa.gov

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

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

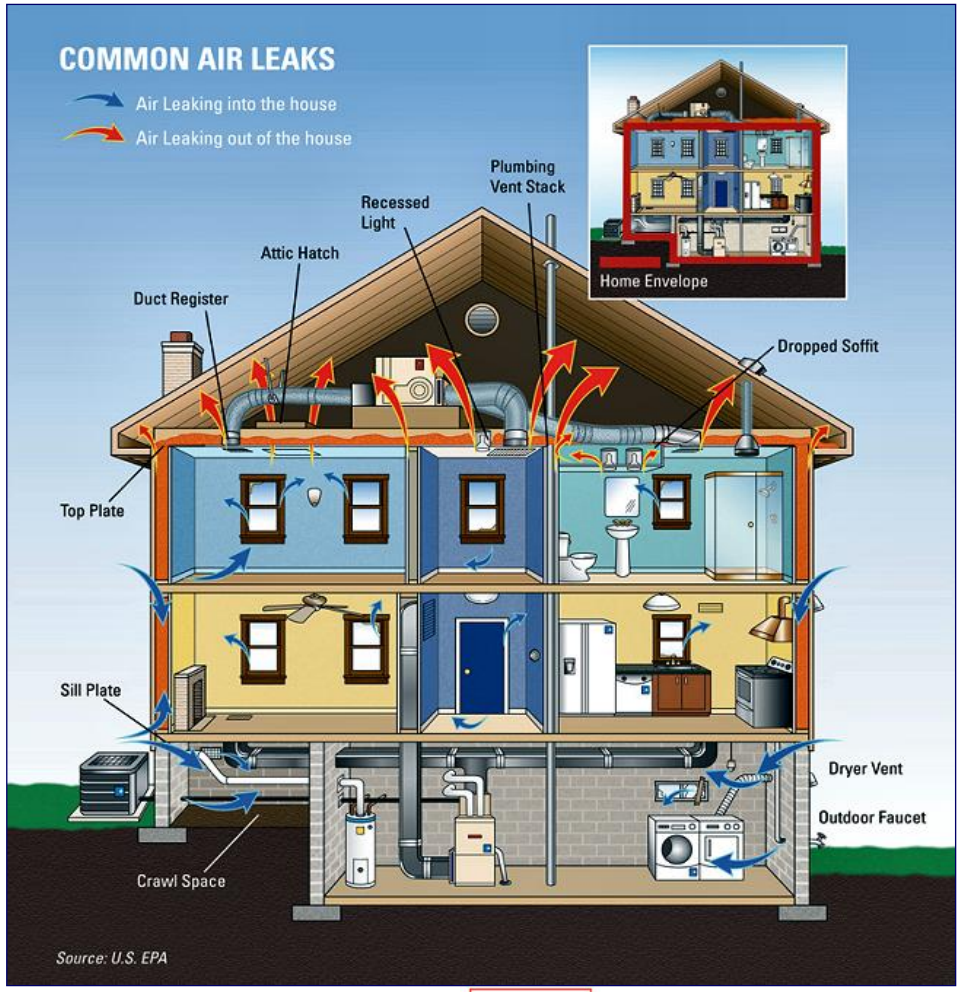


Image: epa.gov

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL®

Insulation

- Energy efficiency is maximized in homes that address these insulation issues strategically:
  - Placement
  - Type
  - Installation

Image: fmlink.com

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

Insulation - Placement

- Limiting airflow is a key factor for insulation effectiveness.
- Insulation should be in contact with the air barrier and entirely encapsulated.

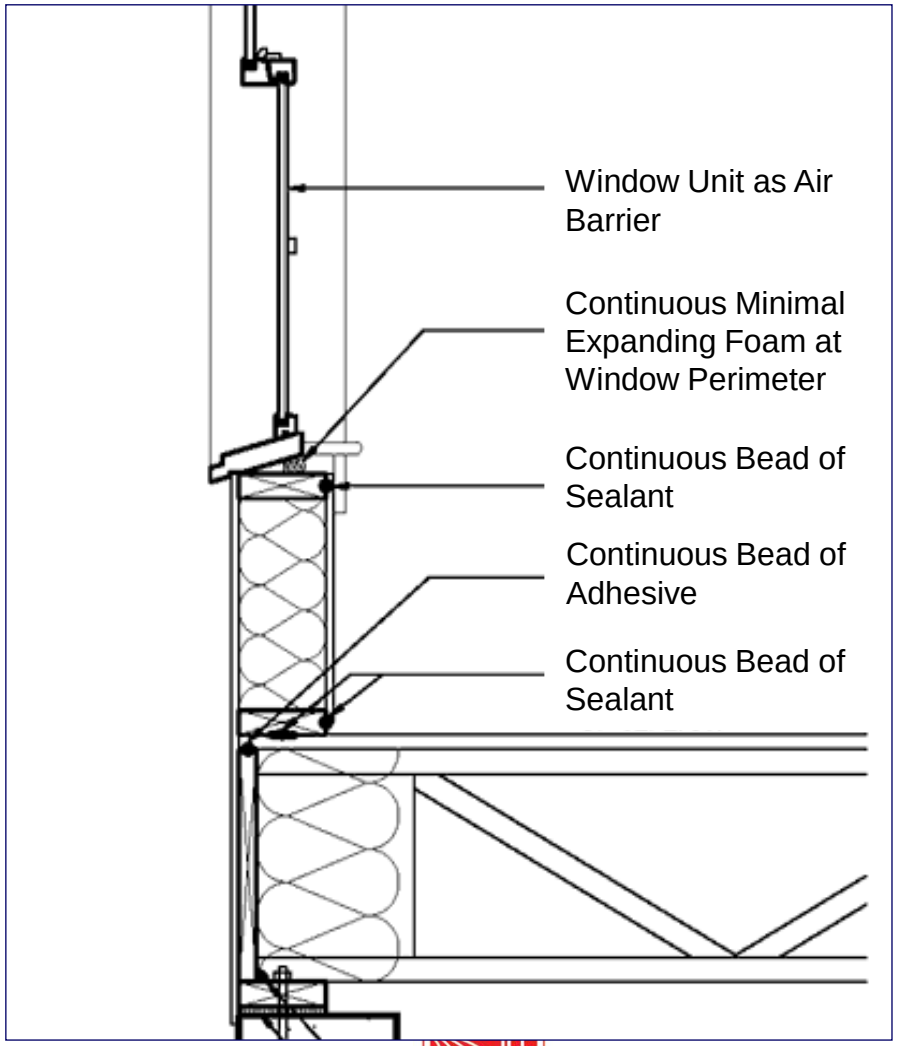


Image: basc.pnnl.gov

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

INTERNATIONAL CODE COUNCIL

Insulation - Type

The energy code does not require specific types of insulation, only required R-value

Materials:

- Fiberglass
- Cellulose
- Low-density or open-cell foam
- High-density or closed-cell foam
- Foam sheathing

Forms:

- Batts and blankets
- Loose-fill and blown-in
- Damp spray (cellulose, spider micro-filament fiberglass)
- Blown-in batt system (BIBS)
- Dense pack insulation
- Foams (sheet-applied)
- Foams (spray-applied)
- Reflective systems

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

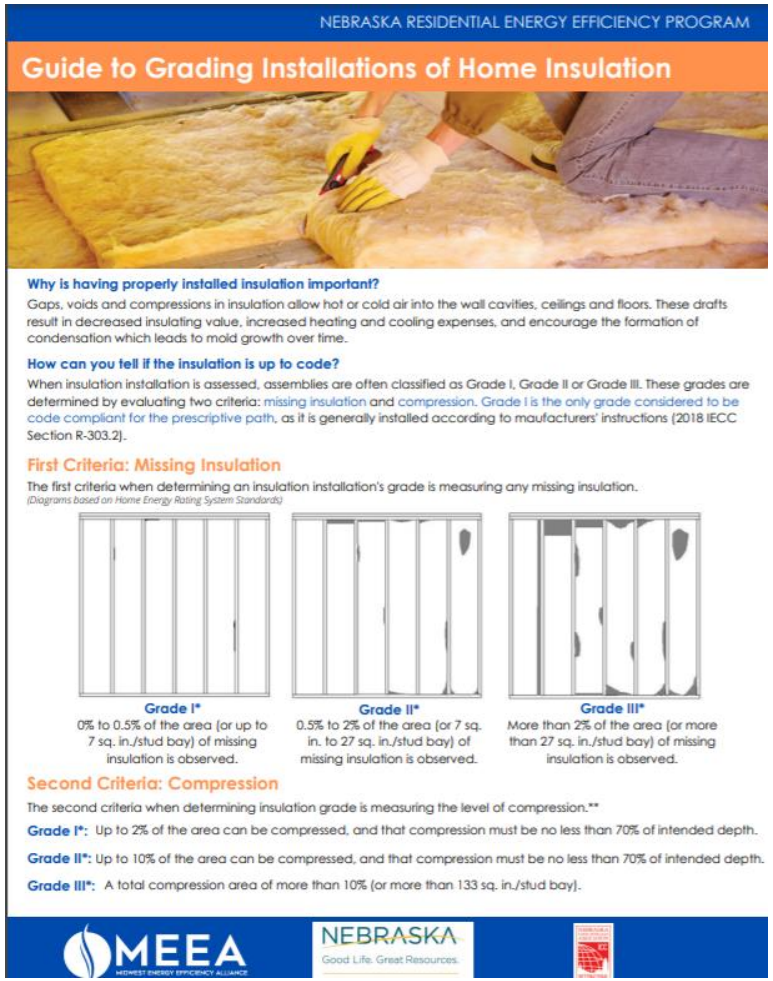
NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

Insulation - Installation

- Inspection ratings:
  - Grade 1: Installed correctly (code required)
  - Grade 2: You tried, but not quite there
  - Grade 3: You've got to be kidding me!

  R-value:
  - Indicates a material's resistance to heat flow
- U-factor:
  - Indicates rate of heat loss by the product or assembly



NEBRASKA RESIDENTIAL ENERGY EFFICIENCY PROGRAM

Guide to Grading Installations of Home Insulation

Why is having properly installed insulation important?

Gaps, voids and compressions in insulation allow hot or cold air into the wall cavities, ceilings and floors. These drafts result in decreased insulating value, increased heating and cooling expenses, and encourage the formation of condensation which leads to mold growth over time.

How can you tell if the insulation is up to code?

When insulation installation is assessed, assemblies are often classified as Grade I, Grade II or Grade III. These grades are determined by evaluating two criteria: missing insulation and compression. Grade I is the only grade considered to be code compliant for the prescriptive path, as it is generally installed according to maufacturers' instructions (2018 IECC Section R-303.2).

First Criteria: Missing Insulation

The first criteria when determining an insulation installation's grade is measuring any missing insulation.

(Diagrams based on Home Energy Rating System Standards)

Grade I*
0% to 0.5% of the area (or up to 7 sq. in./stud bay) of missing insulation is observed.

Grade II*
0.5% to 2% of the area (or 7 sq. in. to 27 sq. in./stud bay) of missing insulation is observed.

Grade III*
More than 2% of the area (or more than 27 sq. in./stud bay) of missing insulation is observed.

Second Criteria: Compression

The second criteria when determining insulation grade is measuring the level of compression.**

Grade I*: Up to 2% of the area can be compressed, and that compression must be no less than 70% of intended depth.

Grade II*: Up to 10% of the area can be compressed, and that compression must be no less than 70% of intended depth.

Grade III*: A total compression area of more than 10% (or more than 133 sq. in./stud bay).

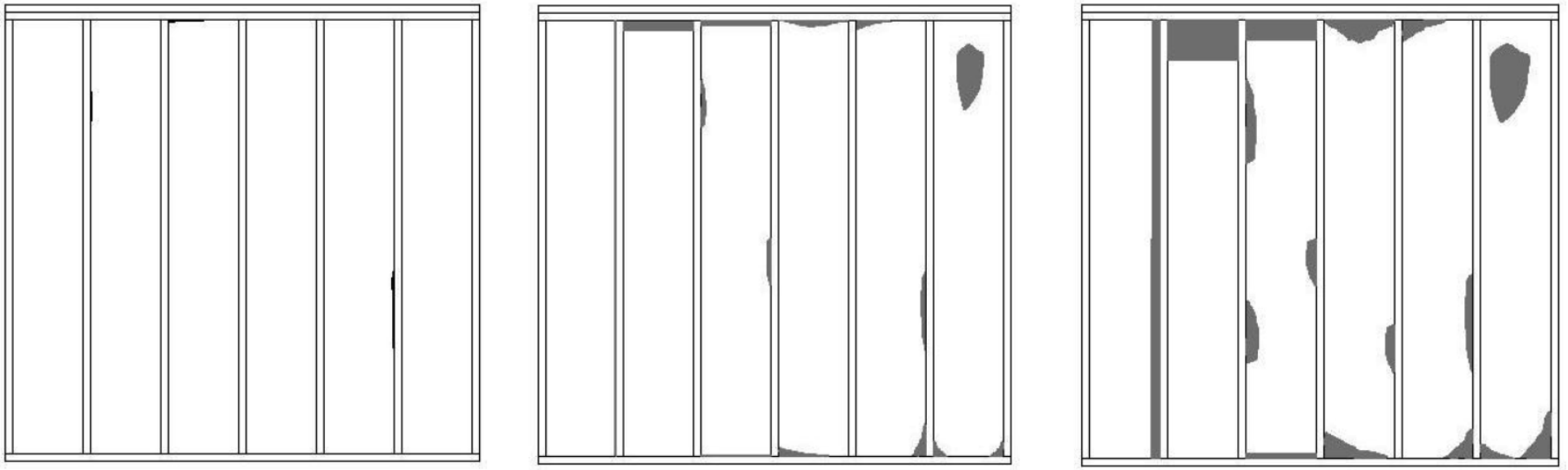
MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

Batt Insulation Grading

Code Compliant — **Not Acceptable**



Grade I: Almost no gaps

Grade II: Up to 2%

Grade III: 2% - 5%

RESNET protocol for the effect of missing insulation on installation grade

Diagrams from the HERS Standards

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

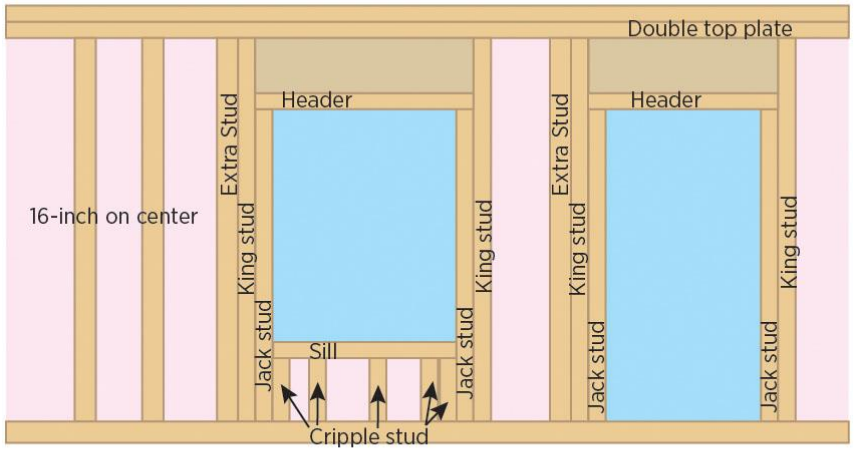
NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

Alternative Systems

- Alternative framing techniques can make holistic improvements to a building envelope assembly. For example:
  - Increase stud spacing to 24 inches on center and raise headers above the top plate or hung on single jacks with header hangers:
    - U-factor: 0.058 to 0.055
    - R-value: 17.24 to 18.18
  - Double stud wall assemblies and truss wall assemblies
  - SIPs, ICFs and precast concrete

Traditional Framing



Advanced Framing Techniques

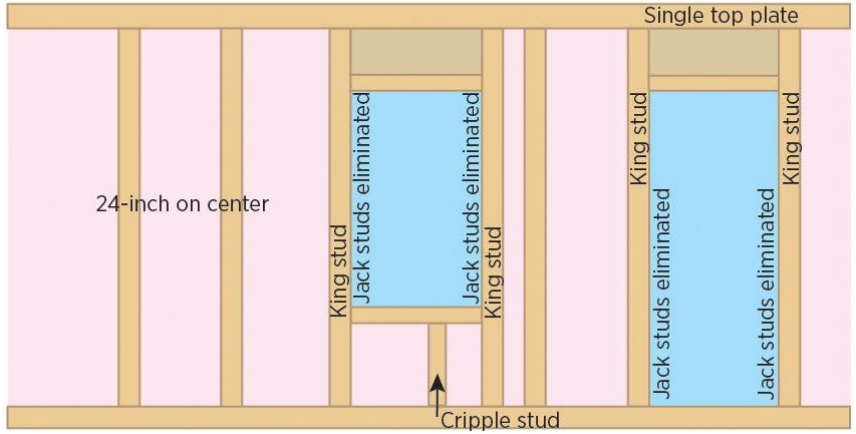


Image: Pacific Northwest National

Thermal Envelope

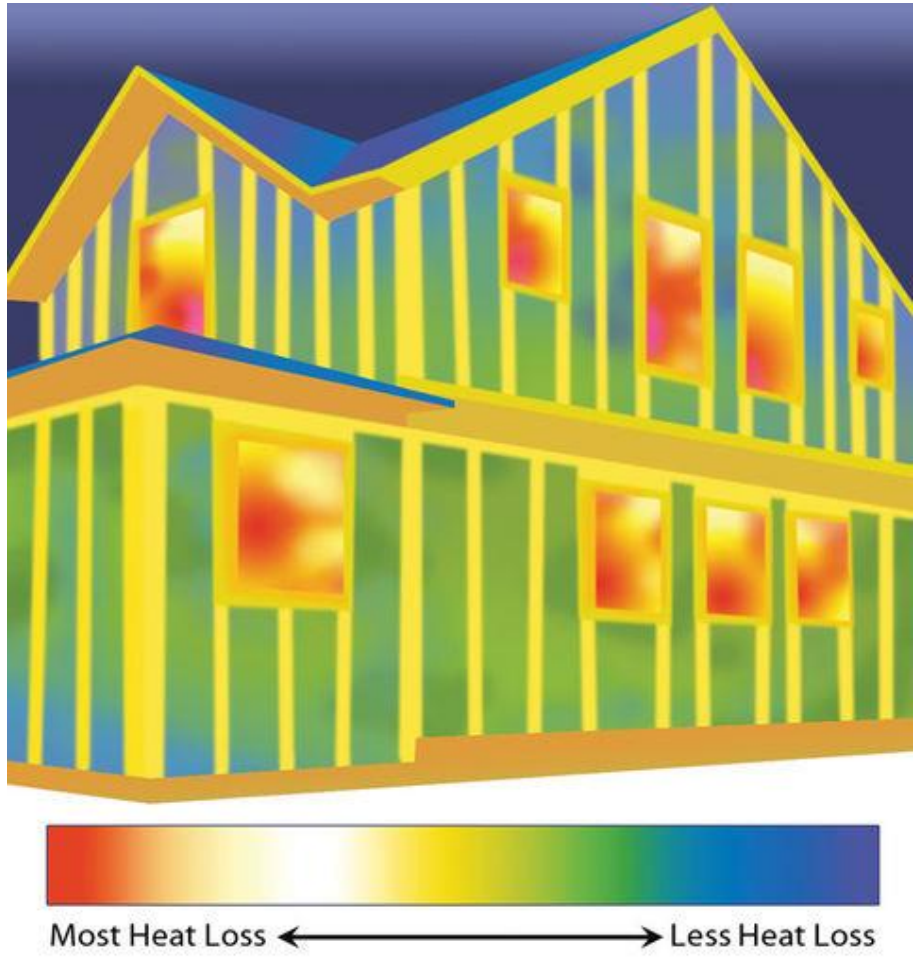


Image: buildinggreen.com

Reducing Thermal Bridging

Anybody see a problem here?

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

Thermal Envelope - Moisture Control

- Best practices that accommodate building science principles will:
  - Air seal
  - Add thermal performance
  - Manage the moisture that moves through the assembly.
- It can become a fairly complicated issue:
  - Moisture can move in both directions in almost all climate zones.
  - Different materials have differing permeability.
  - Vapor at dew point will convert to bulk moisture

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

Windows, Skylights and Doors

- An average home may **lose 30%** of its heat or air conditioning energy through its windows.
- They lose heat in four ways:
  - Conduction
  - Radiation
  - Convection
  - Air leakage

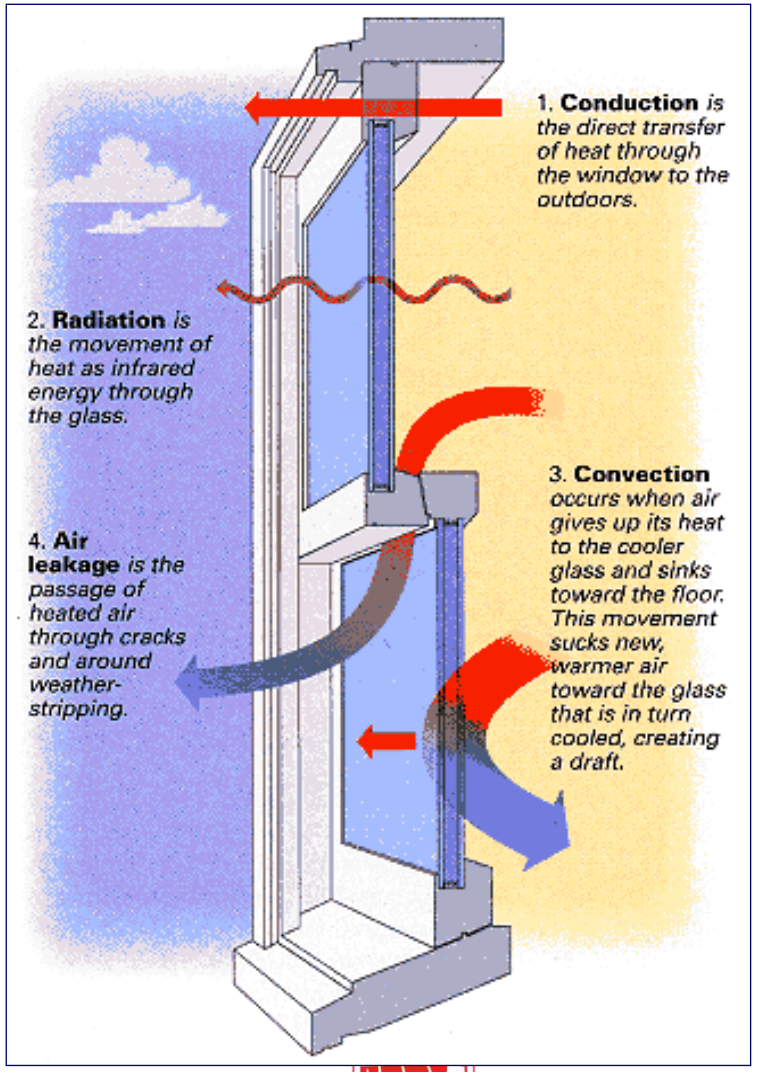


Image: NAHB

Frame and Glazing Options

- Window frame materials have varying conductivity properties:
  - Wood, vinyl, aluminum and fiberglass
  - Thermal breaks
- Glazing options:
  - Insulated glass
  - Low-E glass
  - Low-conductance gas fillings
  - Triple glazing
  - Tints

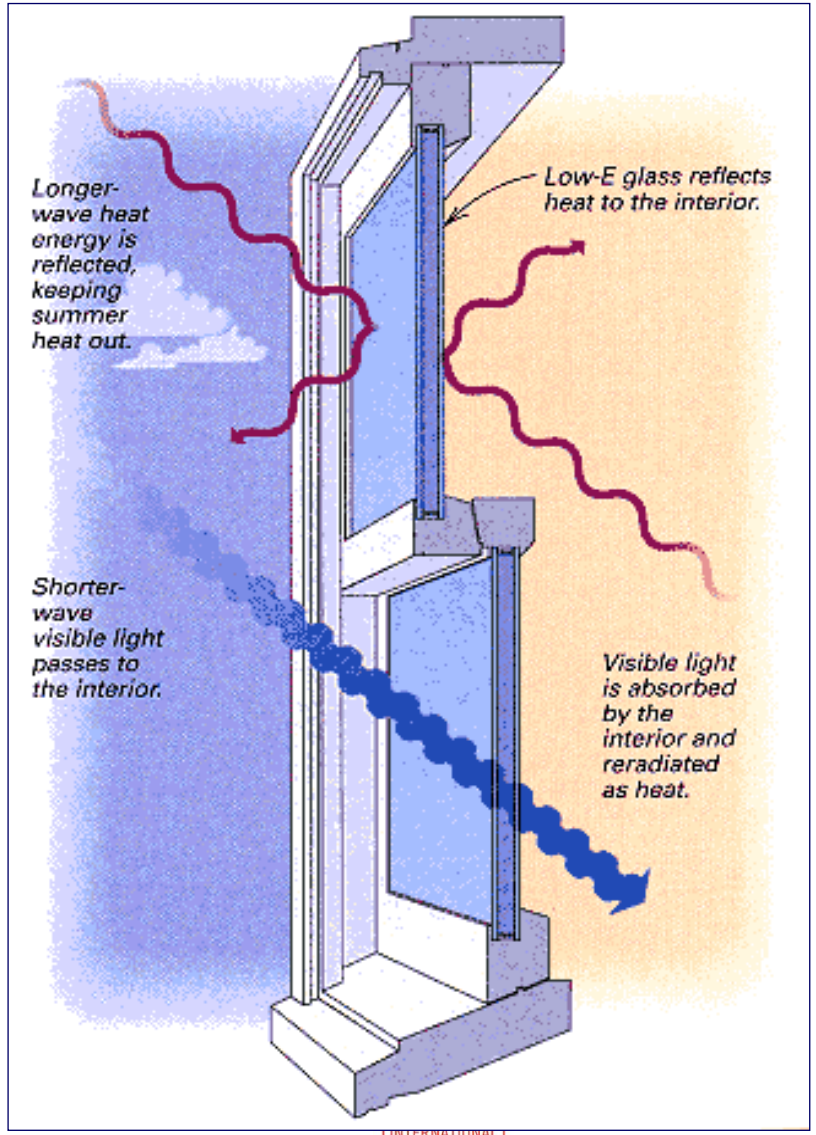


Image: NAHB

Fenestration Ratings

- The National Fenestration Rating Council rating system is helpful for comparing different manufacturers' windows.
- 2018 IECC, Climate Zone 5 (Nebraska) requires windows with:
  - U-factor ≤ 0.30
  - Air leakage ≤ 0.3 cfm/f2
  - No requirement for SHGC

Image: nfrc.org

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL®

Skylights and Doors

- Skylights:
  - Rated the same as windows.
  - Strategies that are useful for windows may not work for skylights.
  - Low solar heat gain coefficient (SHGC) and U-factor skylights are the prudent design choice
    - *2018 IECC skylight U-Factor ≤ 0.55 in Climate Zone 5*
- Doors:
  - The opaque part of door is assigned a U-factor
    - *2018 IECC door U-factor is ≤ 0.3 in Climate Zone 5*
  - The entire door is assigned an air leakage number
    - *2018 IECC air leakage ≤ 0.5 cfm/f^2 in Climate Zone 5*

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

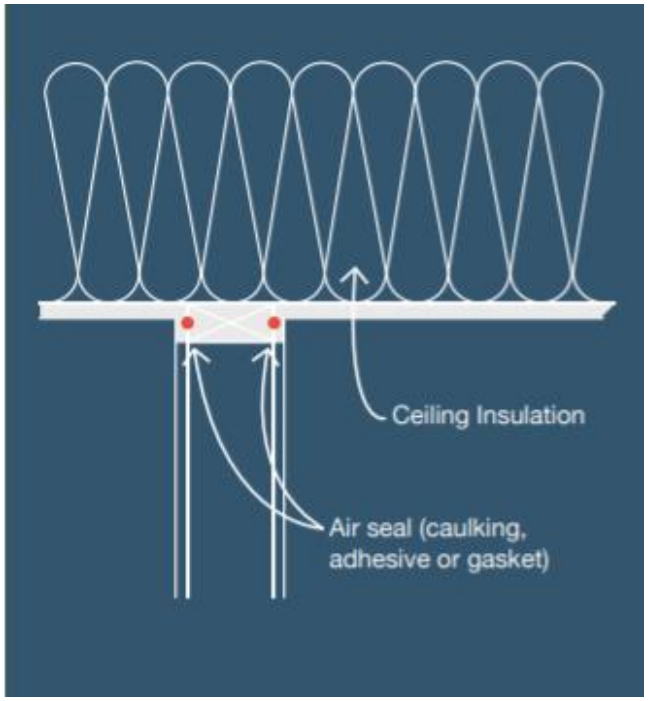
Air Sealing Principles

Importance of Air Sealing

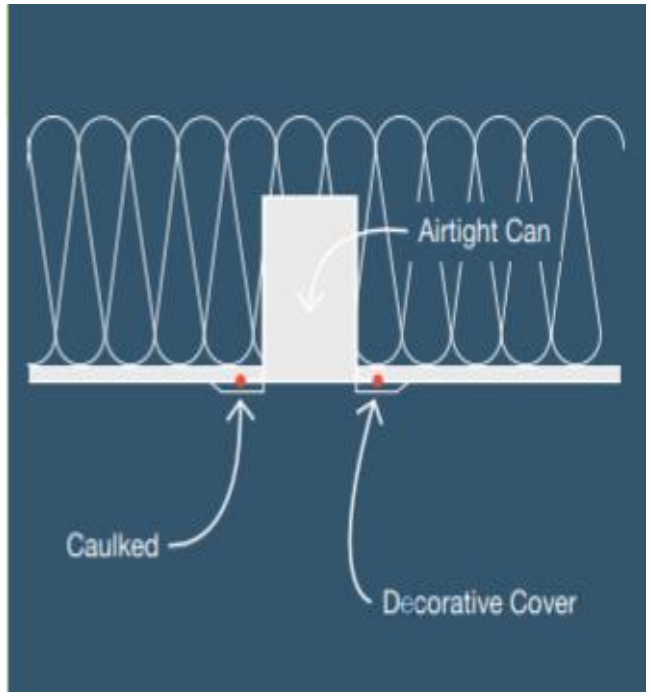
- You can not control the indoor environment if you let the outside in
- Continuous air barrier and thermal barrier are essential
- They will define the HVAC system requirements
- The only way to know envelope tightness is a blower door test

Images: barriersciences.com; energy.gov

Priority Locations for Air Sealing



Top Plate to Attic Drywall



Recessed Light to Finished Surface

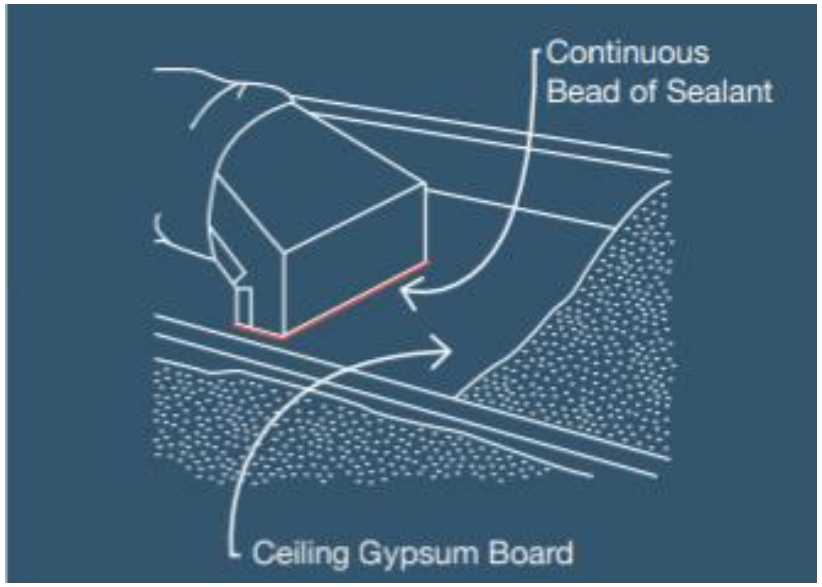
Source: https://insulationinstitute.org/wp-content/uploads/2018/05/N090-5-Air-Sealing-Locations-for-New-Homes.pdf

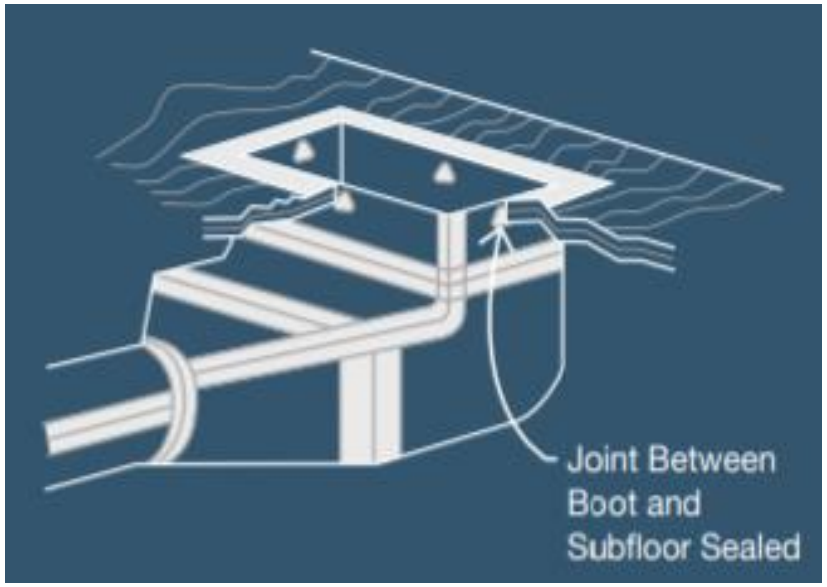
MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

Priority Locations for Air Sealing





Duct Boot to Finished Surface

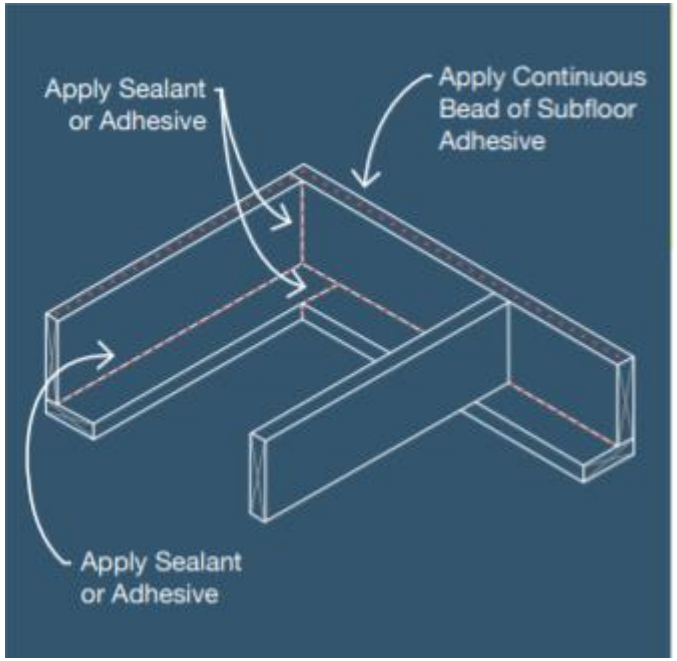
Source: https://insulationinstitute.org/wp-content/uploads/2018/05/N090-5-Air-Sealing-Locations-for-New-Homes.pdf

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

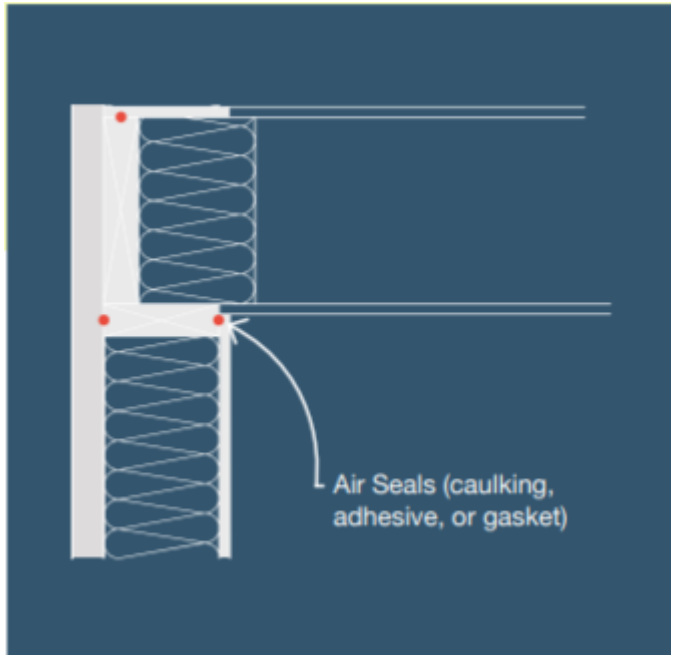
NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

Priority Locations for Air Sealing



Band Joist (Top & Bottom)



Garage House to Common Wall

Source: https://insulationinstitute.org/wp-content/uploads/2018/05/N090-5-Air-Sealing-Locations-for-New-Homes.pdf

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

Ventilation

2018 IECC Mandatory Requirement

Mechanical Ventilation

- Installed according to requirements in the International Mechanical Code
- Required for all homes ≤ 5 ACH50 per Section M303.4
  - Air Leakage rate of 3 ACH50 is a 2018 IECC mandatory requirement

Ventilation

- Mechanical ventilation systems circulate fresh air using ducts and fans, rather than relying on airflow through holes or cracks in a home's walls, roof, or floors
  - You don't know where uncontrolled ventilation draws air from
  - Exhaust fans often do not provide rated / code ventilation post installation – air flow should be tested
- ASHRAE 62.2
  - Establishes ventilation and indoor air quality (IAQ) rates in residential buildings(Low rise)
  - Provides criteria for exhaust fans & spot ventilation
  - Minimum Standard!
- "Build it Tight and Ventilate Right!"

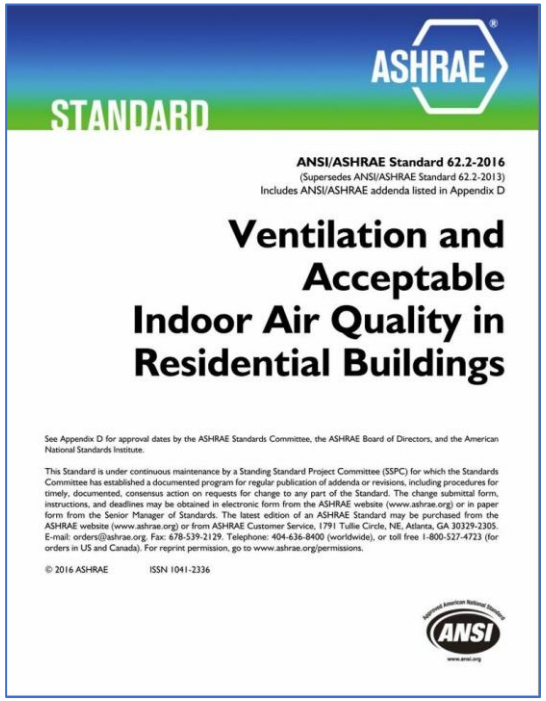


Image:ashrae.org

Ventilation Rate in CFM
(0.01 x total square foot area of house) + [7.5 x (number of bedrooms +1)]

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

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.

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

Ventilation and Air Sealing

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

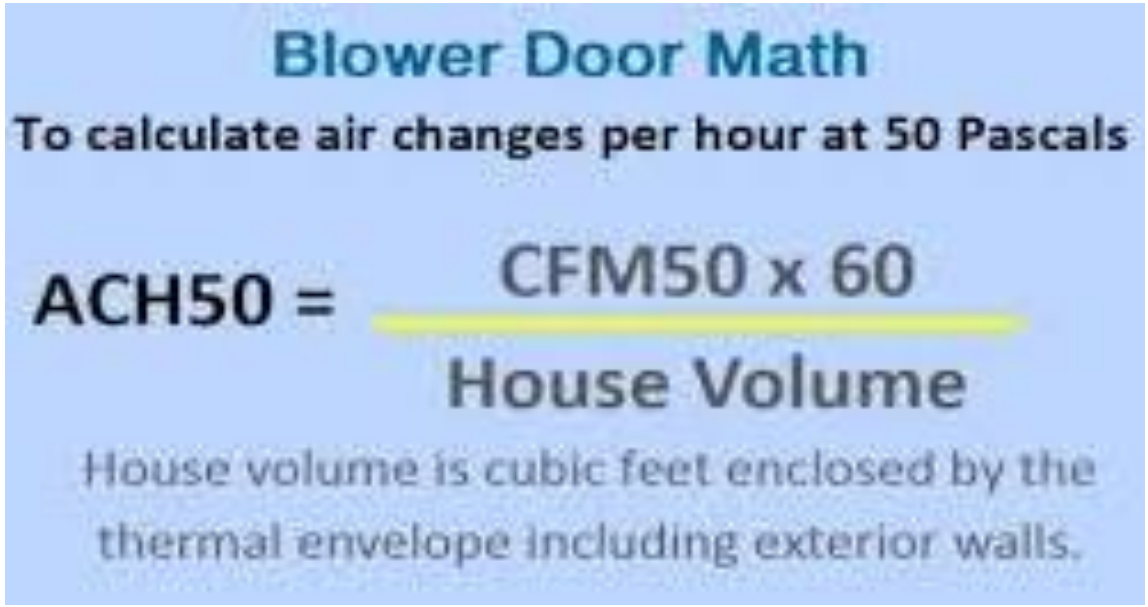
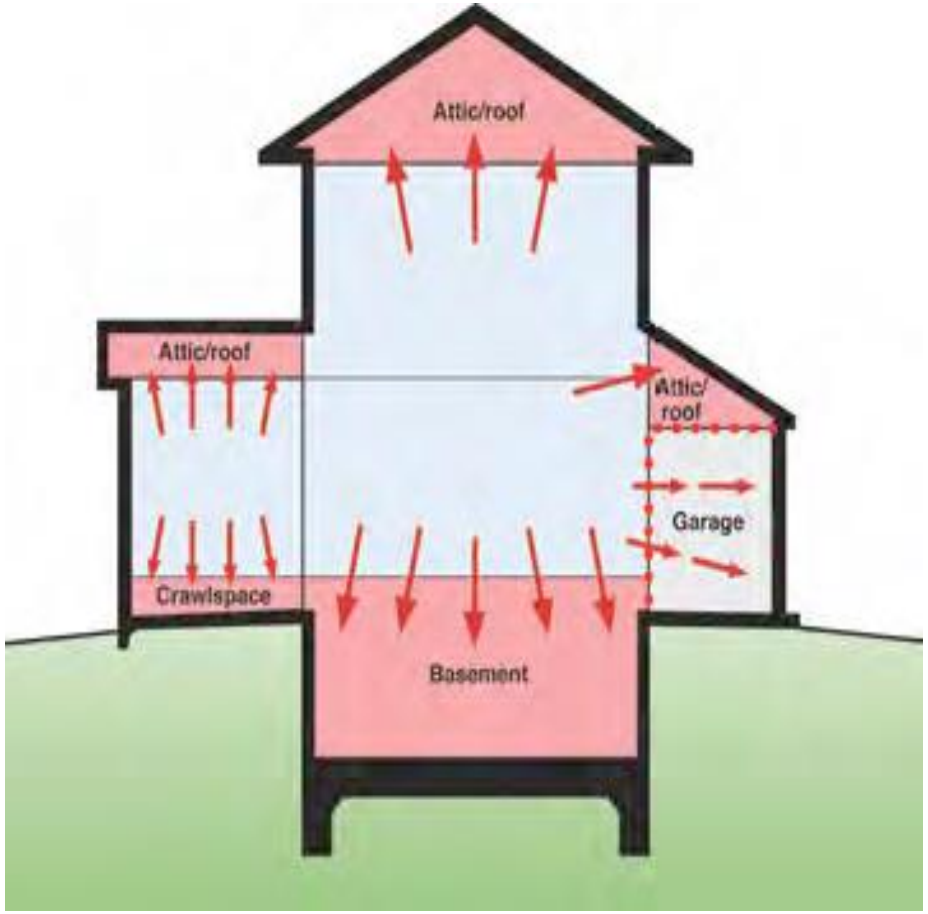


Image: deq.mt.gov

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

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

Ventilation

- Tips and cautions:
  - Natural ventilation may be inadequate or excessive if the indoor environment's driving forces are inadequate.
  - Ventilating air from an unknown source can have a higher level of pollutant than the indoor air (e.g., moisture, pollen, smoke)
    - Balanced whole house ventilation solves this problem
- The priority is to control ventilation:
  - Spot ventilation systems (supply-only and exhaust-only)
  - Balanced ventilation systems (heat recovery and energy recovery ventilators)

Image: healmyheart.ca

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

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

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

Balanced Ventilation

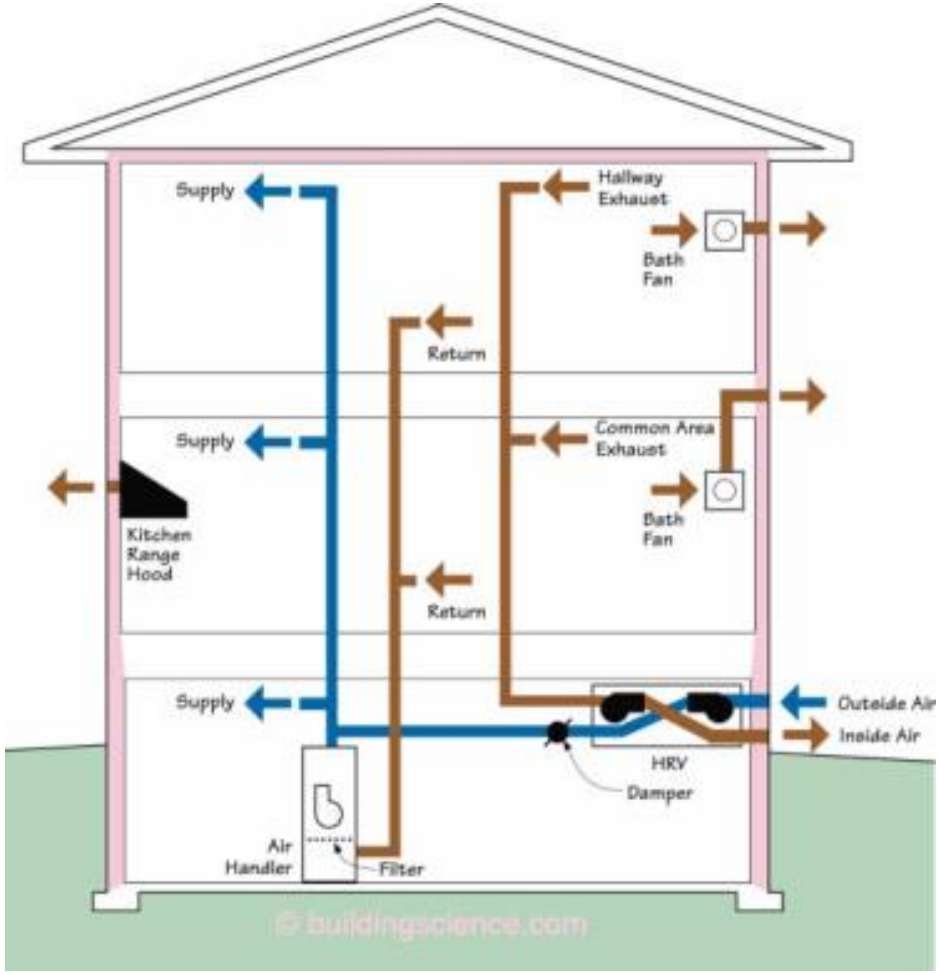


Image: buildingscience.com

- 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

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

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.

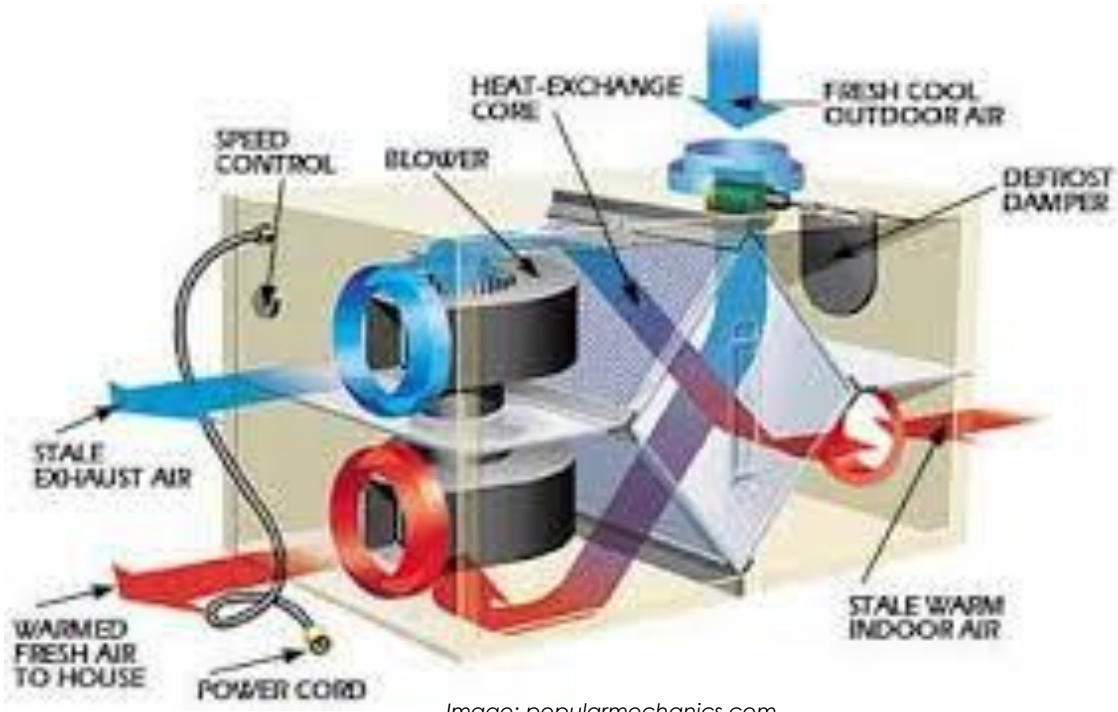


Image: popularmechanics.com

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

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.

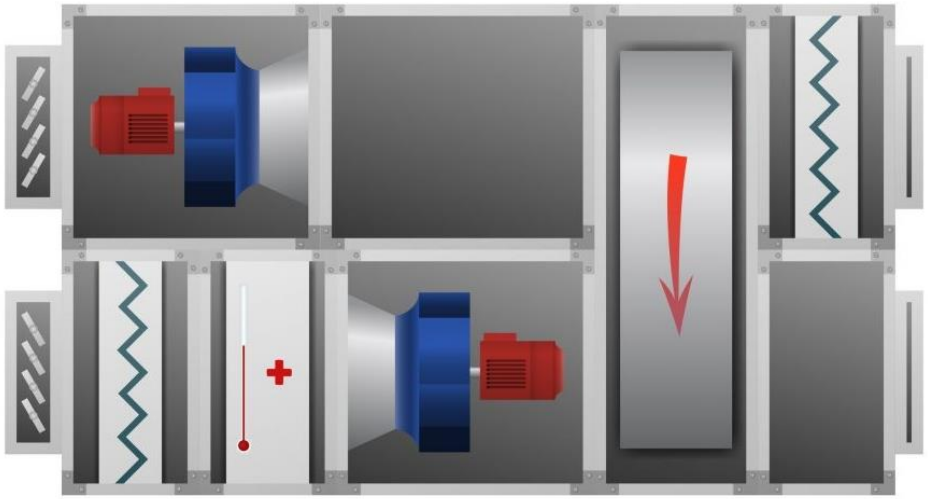


Image: totalcomfortma.com

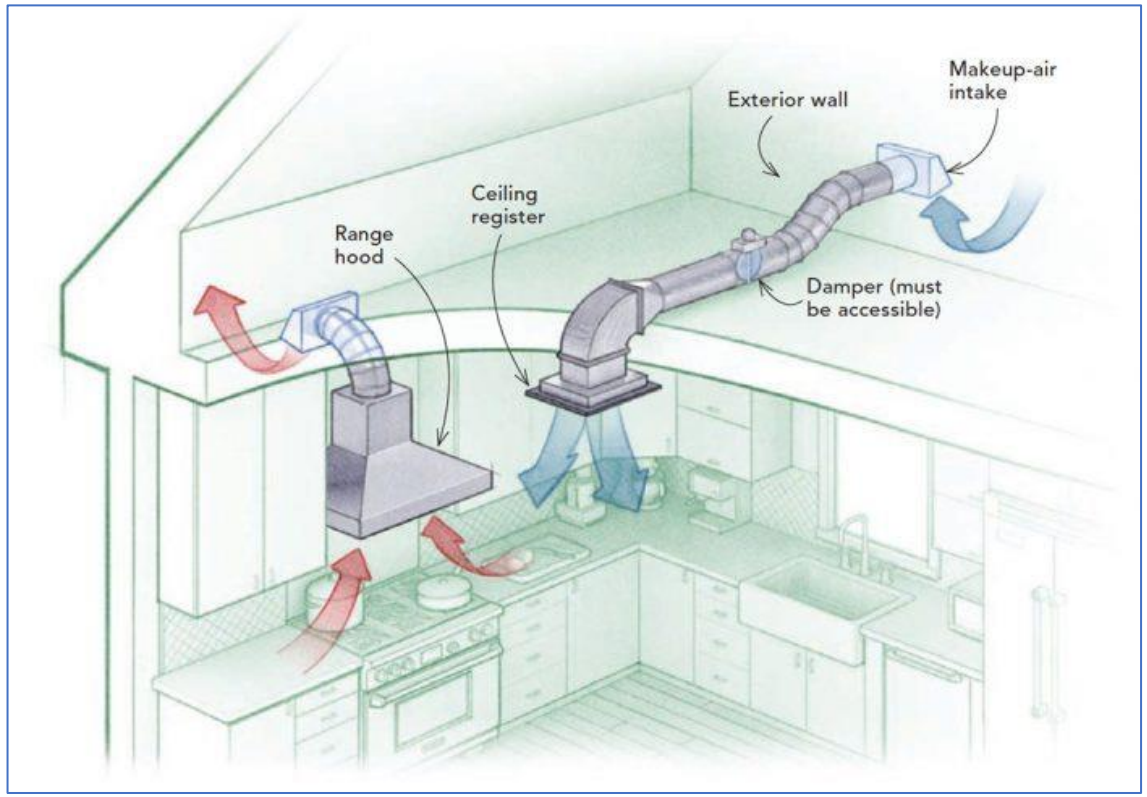
MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

Spot Ventilation (Supply-only and Exhaust-only)

- Supply spot ventilation:
  - Whole house
  - Makeup air or combustion air for appliances
- Exhaust spot ventilation:
  - Bathroom exhaust fan
  - Range hood vent
  - Ducted garage fan
  - Central vacuum
- Fans or portals with humidity-sensitive nylon strips



Images: greenbuildingadvisor.com

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

Performance Testing

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

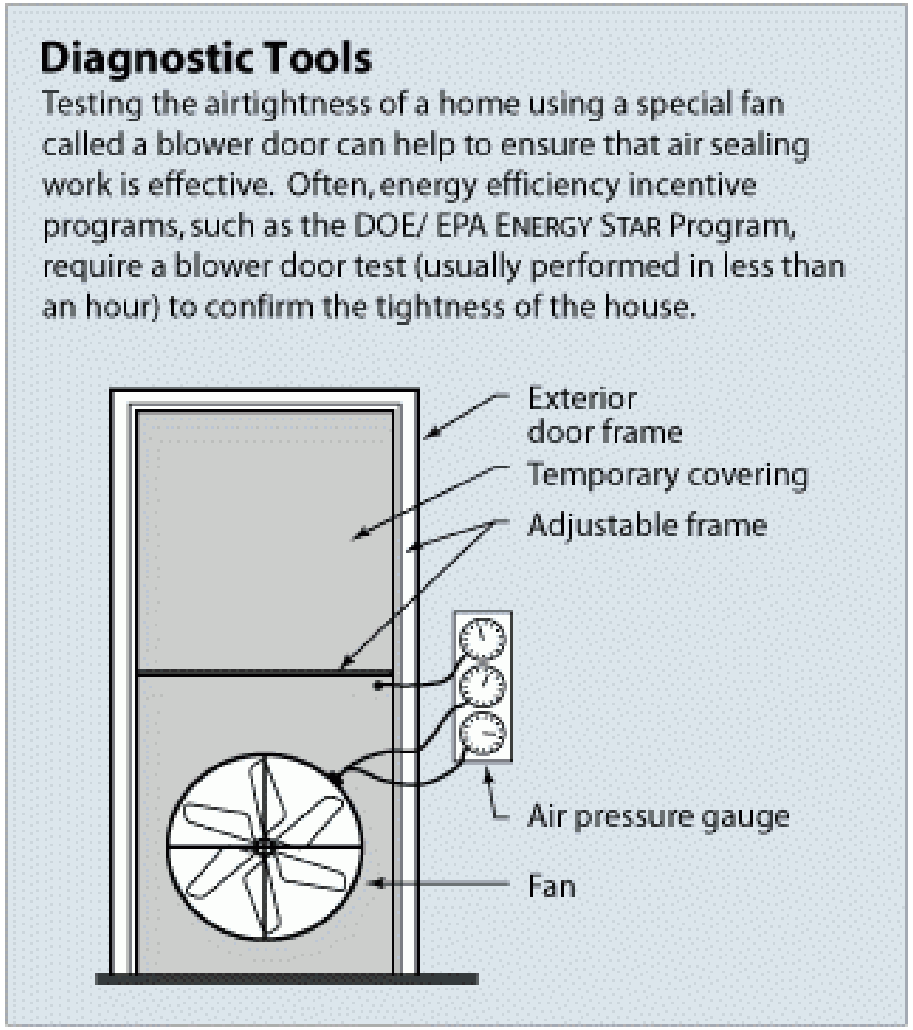


Image: U.S. DOE

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

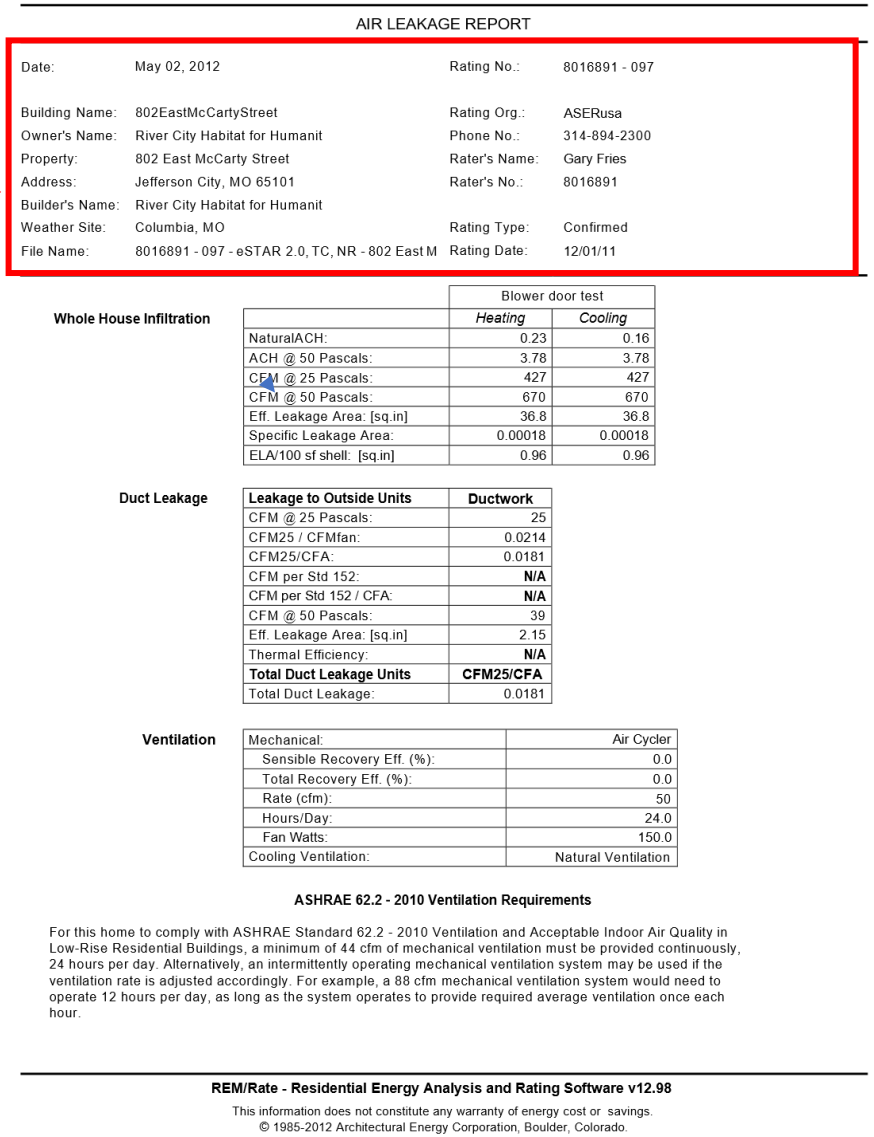
MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

Air Leakage Report

Date:	May 02, 2012	**Rating No.:**	81158891-901
Building Name:	123 Main Street	**Rating Org.:**	Raters USA
Owners Name:	Jane Smith	**Phone:**	555-555-5555
Property Address:	123 Main Street Omaha, NE 68007	**Rater's Name:**	John Williams
Builder's Name:	ABC Construction	**Rater's No:**	1234567
Weather Site:	Omaha, NE	**Rating Type:**	Confirmed
File Name:	101682391-097 eSTAR	**Rating Date:**	12/01/20



AIR LEAKAGE REPORT

Date:	May 02, 2012	Rating No.:	8016891 - 097
Building Name:	802EastMcCartyStreet	Rating Org.:	ASERusa
Owner's Name:	River City Habitat for Humanit	Phone No.:	314-894-2300
Property:	802 East McCarty Street	Rater's Name:	Gary Fries
Address:	Jefferson City, MO 65101	Rater's No.:	8016891
Builder's Name:	River City Habitat for Humanit		
Weather Site:	Columbia, MO	Rating Type:	Confirmed
File Name:	8016891 - 097 - eSTAR 2.0, TC, NR - 802 East M	Rating Date:	12/01/11

Whole House Infiltration

	Blower door test	
	Heating	*Cooling*
NaturalACH:	0.23	0.16
ACH @ 50 Pascals:	3.78	3.78
CFM @ 25 Pascals:	427	427
CFM @ 50 Pascals:	670	670
Eff. Leakage Area: [sq.in]	36.8	36.8
Specific Leakage Area:	0.00018	0.00018
ELA/100 sf shell: [sq.in]	0.96	0.96

Duct Leakage

Leakage to Outside Units	**Ductwork**
CFM @ 25 Pascals:	25
CFM25 / CFMfan:	0.0214
CFM25/CFA:	0.0181
CFM per Std 152:	**N/A**
CFM per Std 152 / CFA:	**N/A**
CFM @ 50 Pascals:	39
Eff. Leakage Area: [sq.in]	2.15
Thermal Efficiency:	**N/A**
Total Duct Leakage Units	**CFM25/CFA**
Total Duct Leakage:	0.0181

Ventilation

Mechanical:	Air Cycler
Sensible Recovery Eff. (%):	0.0
Total Recovery Eff. (%):	0.0
Rate (cfm):	50
Hours/Day:	24.0
Fan Watts:	150.0
Cooling Ventilation:	Natural Ventilation

ASHRAE 62.2 - 2010 Ventilation Requirements

For this home to comply with ASHRAE Standard 62.2 - 2010 Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings, a minimum of 44 cfm of mechanical ventilation must be provided continuously, 24 hours per day. Alternatively, an intermittently operating mechanical ventilation system may be used if the ventilation rate is adjusted accordingly. For example, a 88 cfm mechanical ventilation system would need to operate 12 hours per day, as long as the system operates to provide required average ventilation once each hour.

REM/Rate - Residential Energy Analysis and Rating Software v12.98

This information does not constitute any warranty of energy cost or savings.

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

INTERNATIONAL CODE COUNCIL

Air Leakage Report

Whole House Infiltration

	Blower Door Test	
	Heating	*Cooling*
Natural ACH:	0.23	0.16
ACH @ 50 Pascals:	3.78	3.78
CFM @ 25 Pascals:	427	427
CFM @ 50 Pascals:	670	670
Eff. Leakage Area (sq. in)	36.8	36.8
Specific Leakage Area:	0.00018	0.00018
ELA/100 sf shell (sq. in)	0.96	0.96

AIR LEAKAGE REPORT

Date:	May 02, 2012	Rating No.:	8016891 - 097
Building Name:	802EastMcCartyStreet	Rating Org.:	ASERusa
Owner's Name:	River City Habitat for Humanit	Phone No.:	314-894-2300
Property:	802 East McCarty Street	Rater's Name:	Gary Fries
Address:	Jefferson City, MO 65101	Rater's No.:	8016891
Builder's Name:	River City Habitat for Humanit		
Weather Site:	Columbia, MO	Rating Type:	Confirmed
File Name:	8016891 - 097 - eSTAR 2.0, TC, NR - 802 East M	Rating Date:	12/01/11

Whole House Infiltration

	Blower door test	
	Heating	*Cooling*
NaturalACH:	0.23	0.16
ACH @ 50 Pascals:	3.78	3.78
CFM @ 25 Pascals:	427	427
CFM @ 50 Pascals:	670	670
Eff. Leakage Area: [sq.in]	36.8	36.8
Specific Leakage Area:	0.00018	0.00018
ELA/100 sf shell: [sq.in]	0.96	0.96

Duct Leakage

Leakage to Outside Units	**Ductwork**
CFM @ 25 Pascals:	25
CFM25 / CFMfan:	0.0214
CFM25/CFA:	0.0181
CFM per Std 152:	**N/A**
CFM per Std 152 / CFA:	**N/A**
CFM @ 50 Pascals:	39
Eff. Leakage Area: [sq.in]	2.15
Thermal Efficiency:	**N/A**
Total Duct Leakage Units	**CFM25/CFA**
Total Duct Leakage:	0.0181

Ventilation

Mechanical:	Air Cycler
Sensible Recovery Eff. (%):	0.0
Total Recovery Eff. (%):	0.0
Rate (cfm):	50
Hours/Day:	24.0
Fan Watts:	150.0
Cooling Ventilation:	Natural Ventilation

ASHRAE 62.2 - 2010 Ventilation Requirements

For this home to comply with ASHRAE Standard 62.2 - 2010 Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings, a minimum of 44 cfm of mechanical ventilation must be provided continuously, 24 hours per day. Alternatively, an intermittently operating mechanical ventilation system may be used if the ventilation rate is adjusted accordingly. For example, a 88 cfm mechanical ventilation system would need to operate 12 hours per day, as long as the system operates to provide required average ventilation once each hour.

REM/Rate - Residential Energy Analysis and Rating Software v12.98

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

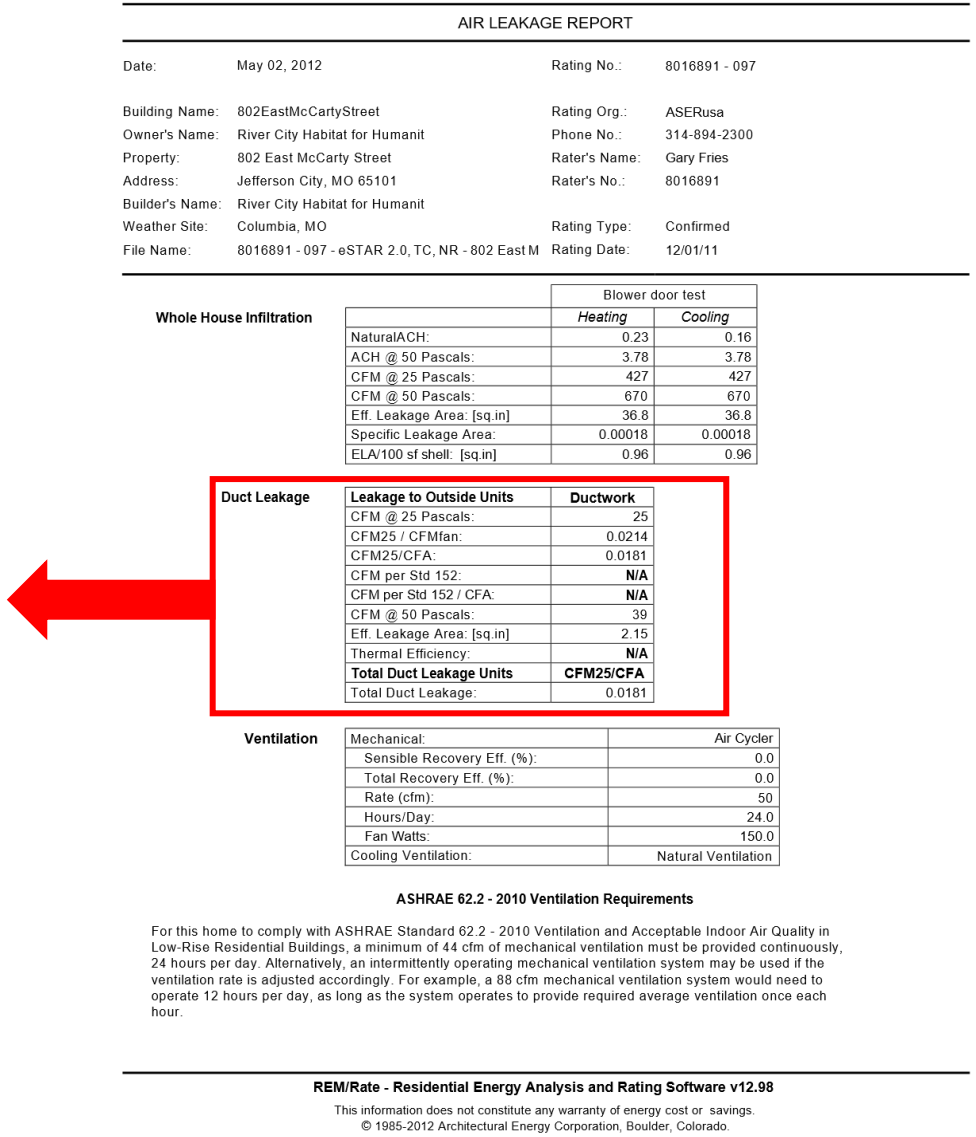
NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

INTERNATIONAL CODE COUNCIL

Air Leakage Report

Duct Leakage

Leakage to Outside Units	Ductwork
CFM @ 25 Pascals:	25
CFM25/CFM fan:	0.0214
CFM25/CFA:	0.0181
CFM per Std 152:	N/A
CFM per Std 152/CFA:	N/A
CFM @ 50 Pascals:	39
Eff. Leakage Area (sq. in.)	2.15
Thermal Efficiency:	N/A
Total Duct Leakage Units:	**CFM25/CFA**
Total Duct Leakage:	0.0181



AIR LEAKAGE REPORT

Date:	May 02, 2012	Rating No.:	8016891 - 097
Building Name:	802EastMcCartyStreet	Rating Org.:	ASERusa
Owner's Name:	River City Habitat for Humanit	Phone No.:	314-894-2300
Property:	802 East McCarty Street	Rater's Name:	Gary Fries
Address:	Jefferson City, MO 65101	Rater's No.:	8016891
Builder's Name:	River City Habitat for Humanit		
Weather Site:	Columbia, MO	Rating Type:	Confirmed
File Name:	8016891 - 097 - eSTAR 2.0, TC, NR - 802 East M	Rating Date:	12/01/11

Whole House Infiltration

	Blower door test	
	Heating	*Cooling*
NaturalACH:	0.23	0.16
ACH @ 50 Pascals:	3.78	3.78
CFM @ 25 Pascals:	427	427
CFM @ 50 Pascals:	670	670
Eff. Leakage Area: [sq.in]	36.8	36.8
Specific Leakage Area:	0.00018	0.00018
ELA/100 sf shell: [sq.in]	0.96	0.96

Duct Leakage

Leakage to Outside Units	Ductwork
CFM @ 25 Pascals:	25
CFM25 / CFMfan:	0.0214
CFM25/CFA:	0.0181
CFM per Std 152:	**N/A**
CFM per Std 152 / CFA:	**N/A**
CFM @ 50 Pascals:	39
Eff. Leakage Area: [sq.in]	2.15
Thermal Efficiency:	**N/A**
Total Duct Leakage Units	**CFM25/CFA**
Total Duct Leakage:	0.0181

Ventilation

Mechanical:	Air Cycler
Sensible Recovery Eff. (%):	0.0
Total Recovery Eff. (%):	0.0
Rate (cfm):	50
Hours/Day:	24.0
Fan Watts:	150.0
Cooling Ventilation:	Natural Ventilation

ASHRAE 62.2 - 2010 Ventilation Requirements

For this home to comply with ASHRAE Standard 62.2 - 2010 Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings, a minimum of 44 cfm of mechanical ventilation must be provided continuously, 24 hours per day. Alternatively, an intermittently operating mechanical ventilation system may be used if the ventilation rate is adjusted accordingly. For example, a 88 cfm mechanical ventilation system would need to operate 12 hours per day, as long as the system operates to provide required average ventilation once each hour.

REM/Rate - Residential Energy Analysis and Rating Software v12.98

This information does not constitute any warranty of energy cost or savings.

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

INTERNATIONAL CODE COUNCIL

Air Leakage Report

Ventilation

Mechanical:	Air Cycler
Sensible Recovery Eff (%):	0.0
Total Recovery Eff (%):	0.0
Rate (cfm):	50
Hours/Day:	24
Fan Watts:	150.0
Cooling Ventilation:	Natural Ventilation

AIR LEAKAGE REPORT

Date:	May 02, 2012	Rating No.:	8016891 - 097
Building Name:	802EastMcCartyStreet	Rating Org.:	ASERusa
Owner's Name:	River City Habitat for Humanit	Phone No.:	314-894-2300
Property:	802 East McCarty Street	Rater's Name:	Gary Fries
Address:	Jefferson City, MO 65101	Rater's No.:	8016891
Builder's Name:	River City Habitat for Humanit		
Weather Site:	Columbia, MO	Rating Type:	Confirmed
File Name:	8016891 - 097 - eSTAR 2.0, TC, NR - 802 East M	Rating Date:	12/01/11

Whole House Infiltration

	Blower door test	
	Heating	*Cooling*
NaturalACH:	0.23	0.16
ACH @ 50 Pascals:	3.78	3.78
CFM @ 25 Pascals:	427	427
CFM @ 50 Pascals:	670	670
Eff. Leakage Area: [sq.in]	36.8	36.8
Specific Leakage Area:	0.00018	0.00018
ELA/100 sf shell: [sq.in]	0.96	0.96

Duct Leakage

Leakage to Outside Units	**Ductwork**
CFM @ 25 Pascals:	25
CFM25 / CFMfan:	0.0214
CFM25/CFA:	0.0181
CFM per Std 152:	**N/A**
CFM per Std 152 / CFA:	**N/A**
CFM @ 50 Pascals:	39
Eff. Leakage Area: [sq.in]	2.15
Thermal Efficiency:	**N/A**
Total Duct Leakage Units	**CFM25/CFA**
Total Duct Leakage:	0.0181

Ventilation

Mechanical:	Air Cycler
Sensible Recovery Eff. (%):	0.0
Total Recovery Eff. (%):	0.0
Rate (cfm):	50
Hours/Day:	24.0
Fan Watts:	150.0
Cooling Ventilation:	Natural Ventilation

ASHRAE 62.2 - 2010 Ventilation Requirements

For this home to comply with ASHRAE Standard 62.2 - 2010 Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings, a minimum of 44 cfm of mechanical ventilation must be provided continuously, 24 hours per day. Alternatively, an intermittently operating mechanical ventilation system may be used if the ventilation rate is adjusted accordingly. For example, a 88 cfm mechanical ventilation system would need to operate 12 hours per day, as long as the system operates to provide required average ventilation once each hour.

REM/Rate - Residential Energy Analysis and Rating Software v12.98

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

INTERNATIONAL CODE COUNCIL

Key Takeaways

- The building envelope is essential for efficiency, comfort, and resilience
- Proper air sealing **and testing** is key to improving indoor air quality, comfort and health of the home
  - Mechanical ventilation must be installed and takes on new importance
- Ventilation
  - Whole house ventilation is required by model code
    - Average house is now built tight enough to need it
    - Balanced ventilation is best practice

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

Questions?

Upcoming Trainings

Residential Energy Code

- Tuesday, January 18, 2022, 11:30 - 1:30 p.m. CT - Residential Energy Code: Mechanical Systems - Register

Commercial Energy Code

- Metropolitan Community College Commercial Energy Code Certificate Course - 8 weeks from January 25-March 15 - Learn more and Register

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

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

Thank you!

Matt Belcher

Matt@verda-solutions.org

Nicole Westfall

nwestfall@mwalliance.org

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL