METROPOLITAN
Community College

Residential Energy Code – Session 6

Best Practices and Non-Code Standards

Instructor – Matt Belcher

March 2, 2021: 6:30 – 8:30 pm

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)
  - Information at end of presentation
- Email nwestfall@mwalliance.org with questions

Today's Agenda

- Best Practices
  - Communication
  - THE Building Envelope
  - Advanced Framing
  - Insulation
  - Structural Insulated Panels
  - Blower Door Testing
  - HVAC Right-Sizing
  - Checklists
- Non-Code Standards
  - Home Energy Rating Score (HERS)
  - Energy Star
  - LEED for Homes
  - Indoor airPlus
  - Passive House
  - Zero Ready Energy Home
  - Active House

BEST PRACTICES

Communication

- Effective Communication = Fewer Headaches
- Communicate early and often
- Establish clear responsibilities, expectations and project goals
  - Can't hit a bullseye without a target
- Encourage questions
- Keep it professional and stick to the facts
- Provide communication training to your workforce

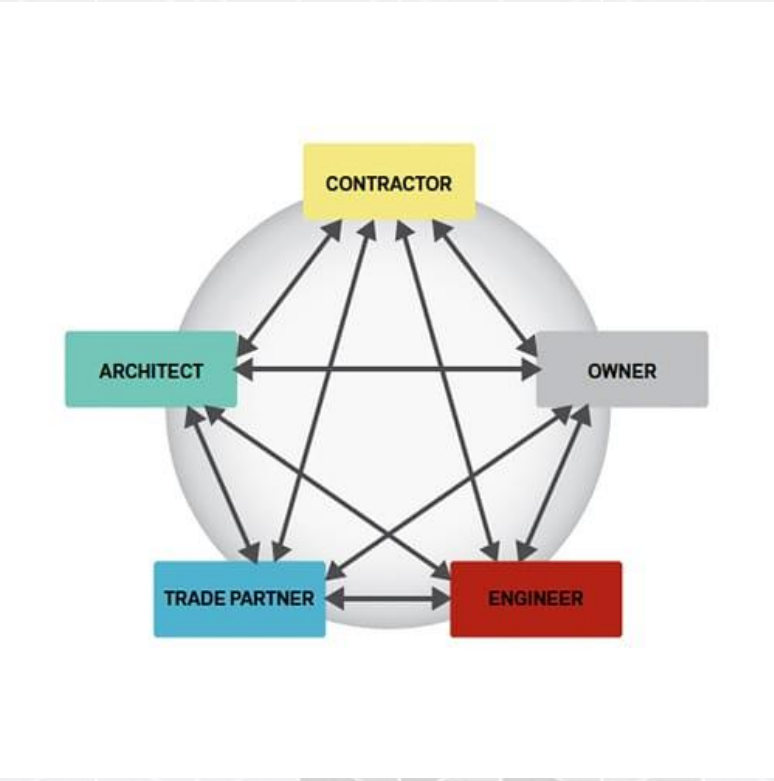


Image: claycorp.com

Communication

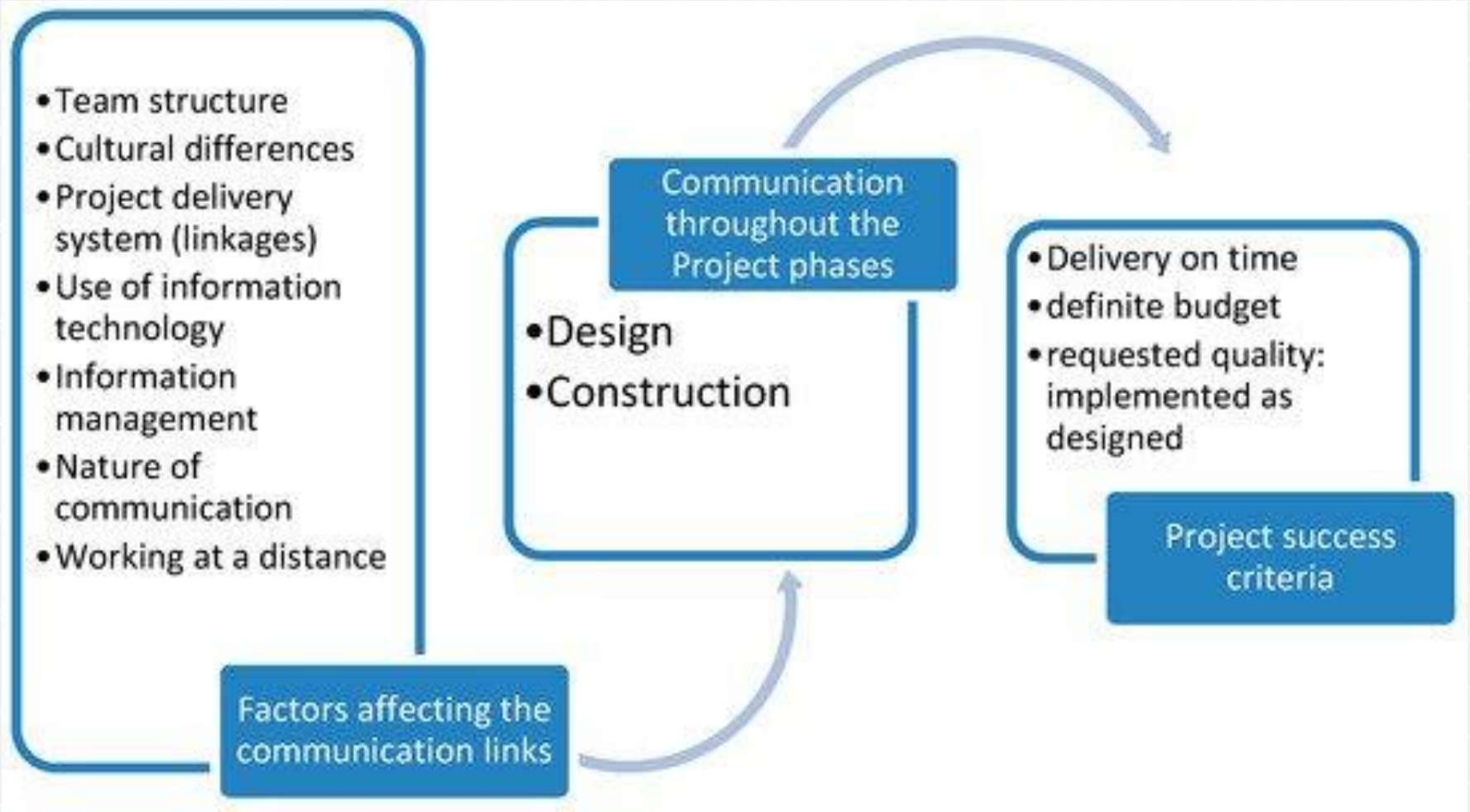


Image: mdpi.com

Communication

- Studies have found that over 35% of construction workers don’t know where to find the information they need to complete their work
  - At an annual cost of ***$177 billion*** to the industry
- With increasing awareness of “house as a system” and cross-trade work, clear communication is critical
  - Avoid jargon
  - Utilize communications technology

Image: bigrentz.com

THE Building 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
    - Don’t skimp on windows

https://sdmultifamilyeuc.com/

Building Envelope

- Four envelope priorities:
  - Bulk moisture management
  - Vapor management
  - Air infiltration management
  - Thermal management
- Energy conservation approaches:
  - Past: increasing R-value or thermal performance
  - Today: eliminating air leakage, providing thermal comfort, and controlling moisture

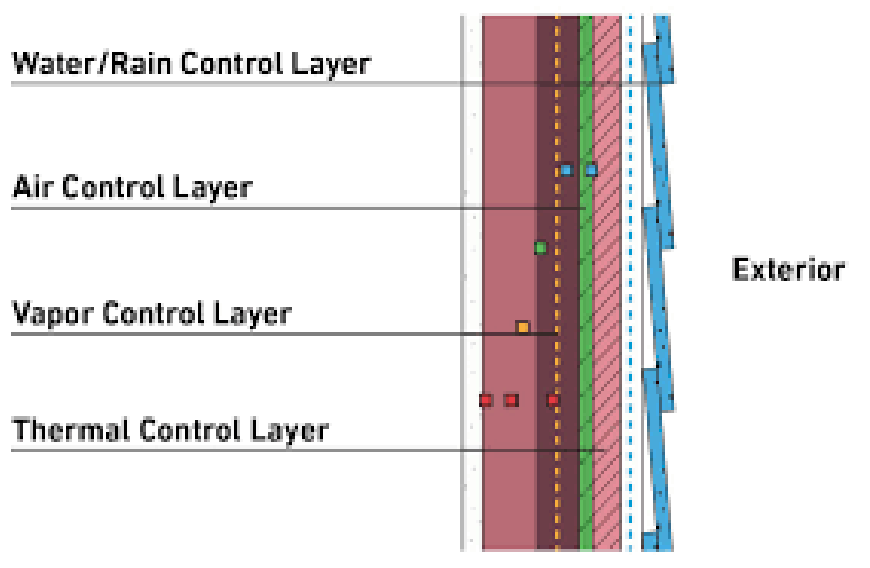


Image: continuingeducation.bnmedia.com

Building Envelope

- Moisture Control Best Practices:
  - Follow building science principles
  - Seal air
  - 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

Building Envelope

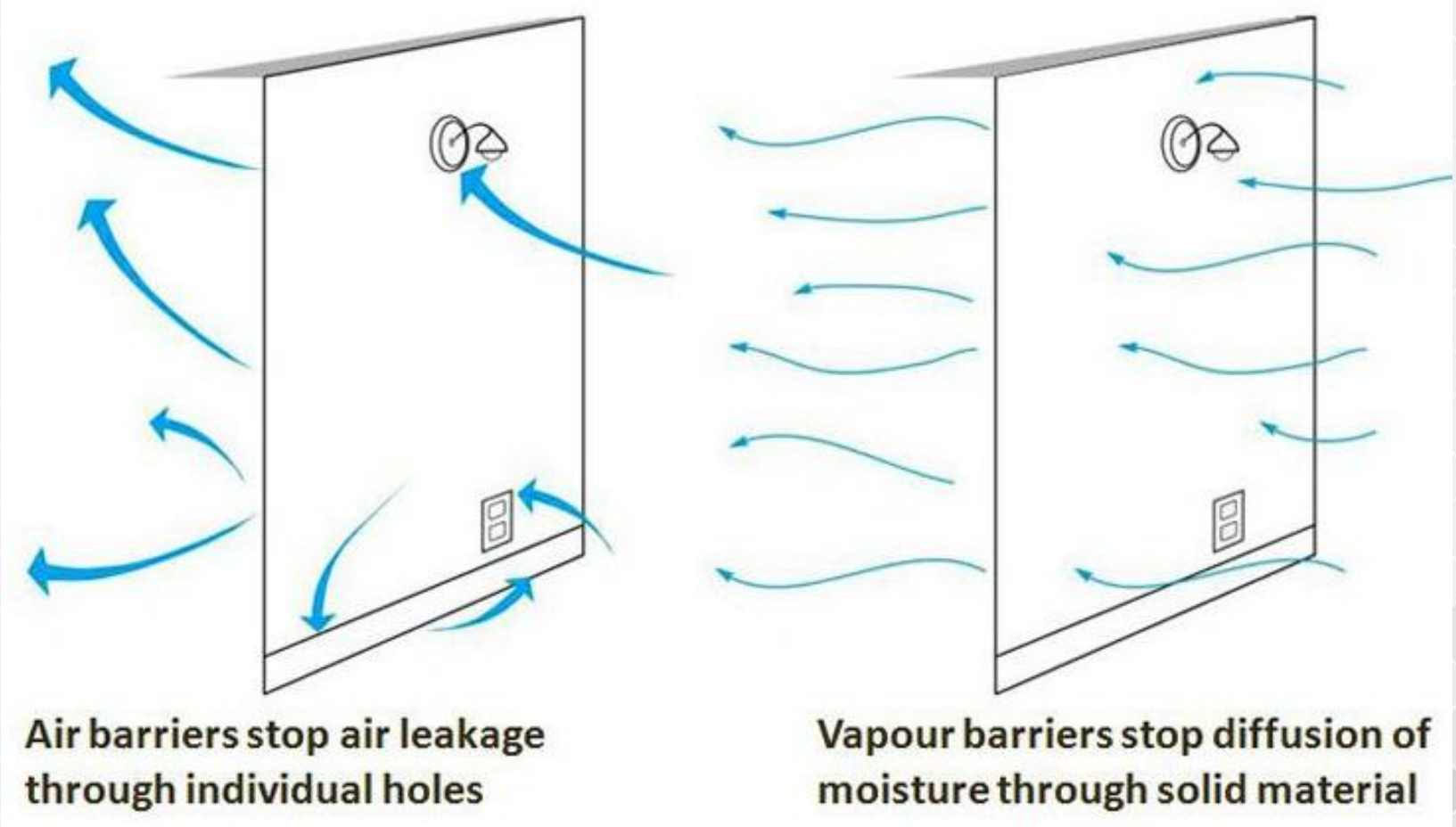


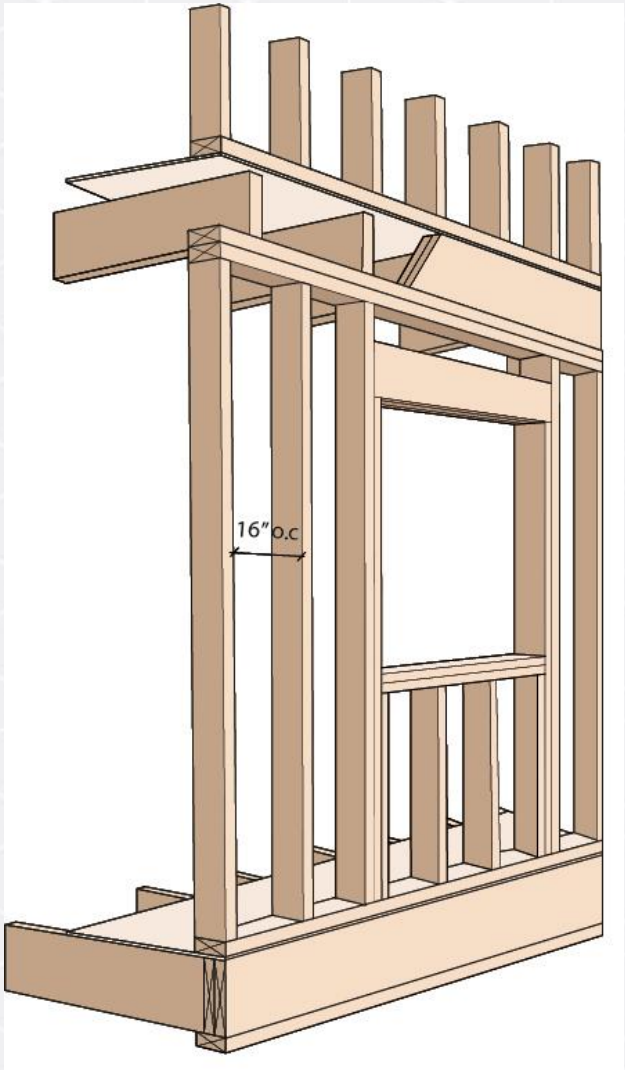
Image: ecohome.net

Advanced Framing

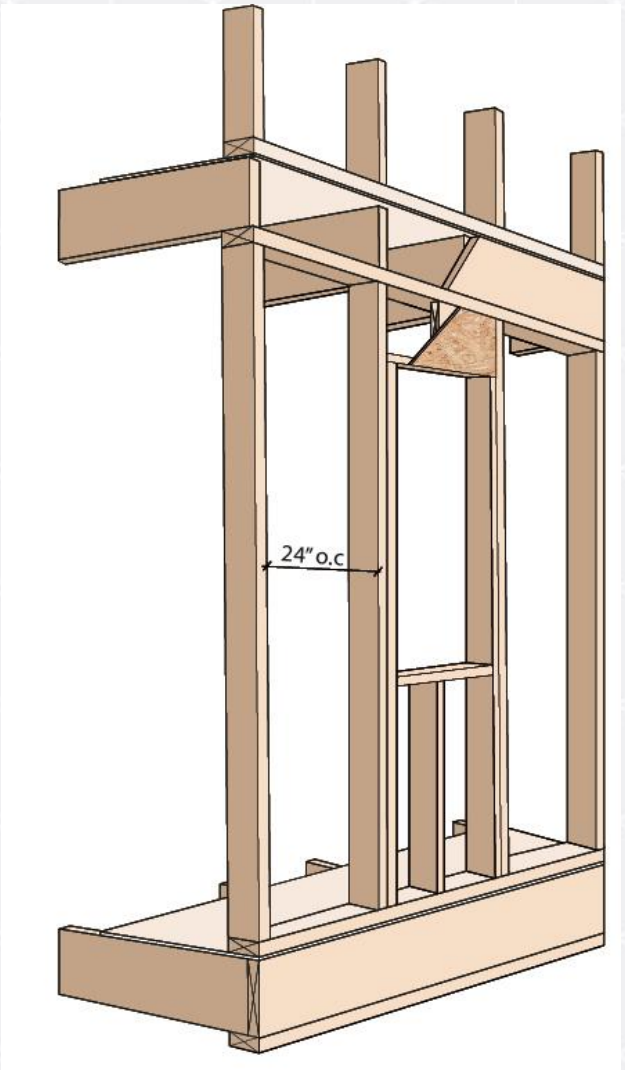
- Minimizes lumber and waste
- 2x6 = structurally sound
- Improves overall wall R-value
  - Fewer studs = more insulation
- Can reduce total cost of framing/wall – less waste
- In-line framing for studs, joists, and rafters at 24” o.c.
- Single lumber headers and top plates
- Two-stud corners

Image: finehomebuilding.com

Advanced Framing



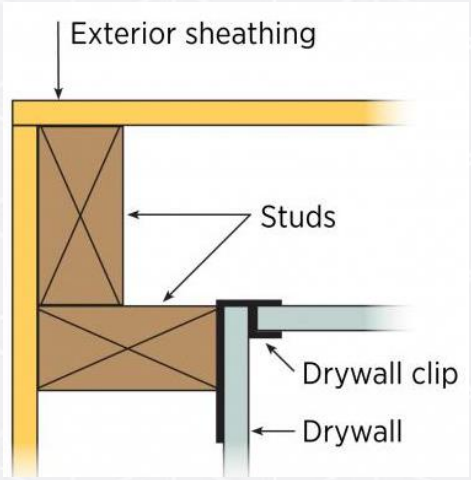
Conventional Framing



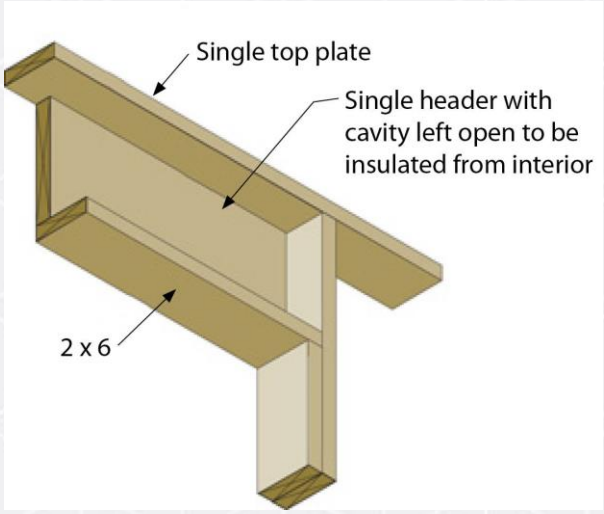
Advanced Framing

Images: greenbuildingadvisor.com;

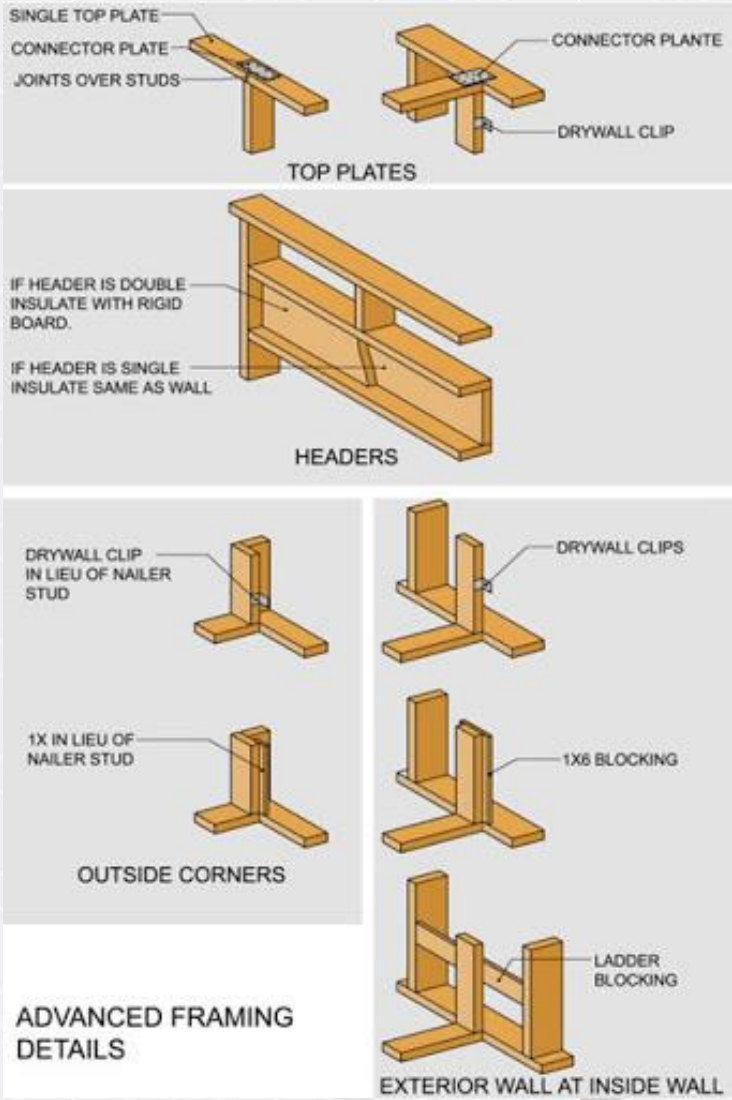
Advanced Framing - Details



Two Stud Corner



Header



Raised Heel Truss

Images: basc.pnnl.com; buildipedia.com; energyvanguard.com

Common Insulation - Types and Forms

Insulation Types

- Fiberglass
- Cellulose
- Low-density spray foam
  - Open Cell
- High-density spray foam
  - Closed-Cell
- Foam sheathing
  - Rigid Insulation

Insulation 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

Common Insulation Types - Pros/Cons

Fiberglass (batt or blown)

Batts: R-2.9 to R-3.8 per inch

Blown: R-2.2 – R-2.9 per inch

- Pros:
  - Inexpensive
  - Does a good job
  - Easily enhanced with air sealing practices.
- Cons:
  - ***Must*** be installed correctly
  - Gets wet, its done!
  - Not a barrier!

Images: energyvanguard.com

Common Insulation Types - Pros/Cons

Cellulose (blown, dense-pack)

Blown: R- 3.1 – R-3.8 per inch

Dense-packed: R-4 per inch

- Pros:
  - Not too expensive
  - Denser so does a better job thermally (barrier)
  - Sprays in cavity
  - Borate treated.
- Cons:
  - More expensive than fiberglass
  - Wet spray, needs to be dry prior to cover!
  - If disturbed hard to repair
  - Borate affected by moisture
  - Not best moisture barrier
  - Shrinkage while drying.

Images: jlconline.com; cellulose.org

Common Insulation Types - Pros/Cons

Rigid Foam:

R-4 to R-6.5 per inch

- Pros:
  - Good to very good insulator
  - Air barrier for exterior installation - must be properly taped
  - Can be used as sheathing
  - Below grade installation insect issues in some locales
- Cons:
  - More expensive than fiberglass or cellulose
  - Must be carefully trimmed for between stud installation
  - Difficult to tightly fit around obstacles or awkward corners

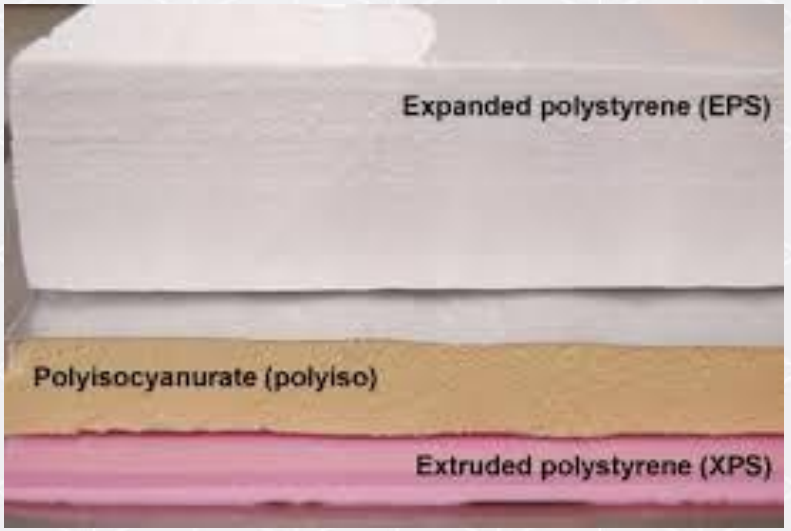


Image: drenergysaver.com

Common Insulation Types - Pros/Cons

Spray Foam:

Open-cell: R-3.7 per inch

Closed-cell: R-6.2 per inch

- Pros*:*
  - *Very* good Insulator/Barrier
  - More resistant to moisture
  - Spray applied, fast dry
  - Fills cavity, little shrinkage
  - Borate treated.
- Cons*:*
  - Expensive
  - Air pockets if not applied correctly, Borates.
- Flash and batt

Images: greenbuildingadvisor.com; finehomebuilding.com

Basement Insulation

- The first issue for finished basements is moisture control
- Exterior insulation is usually the best option, but interior insulation can work too
- Be sure to insulate rim joist!
- Offset studs from foundation to keep things dry
- Comfort is as big a factor as energy for most owners
- Don’t forget about under slab vapor retarder and insulation

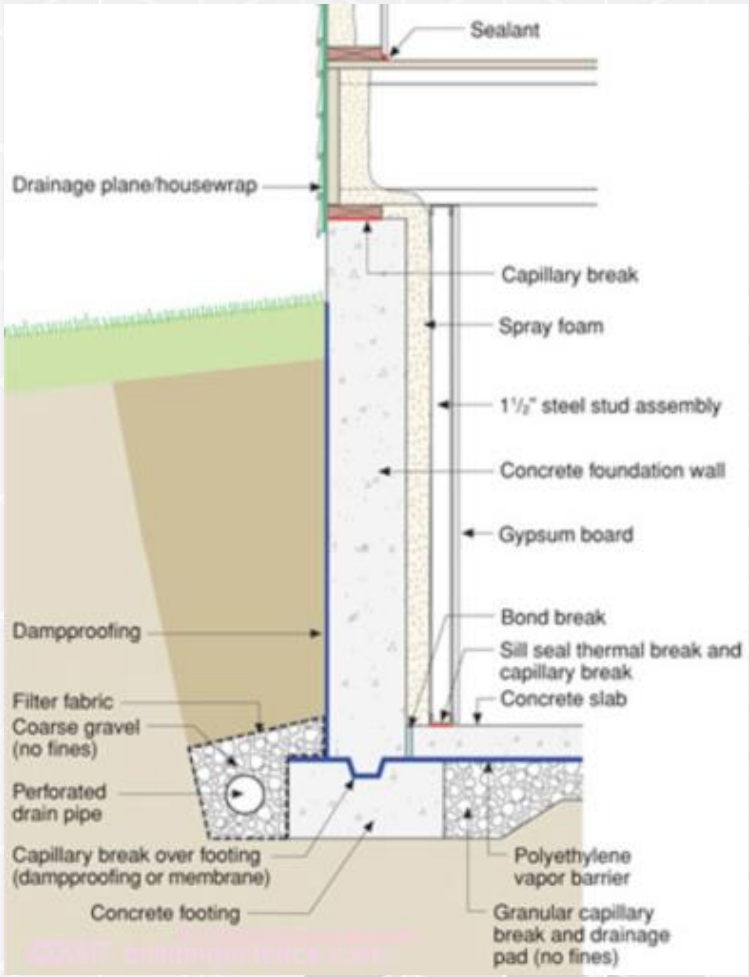
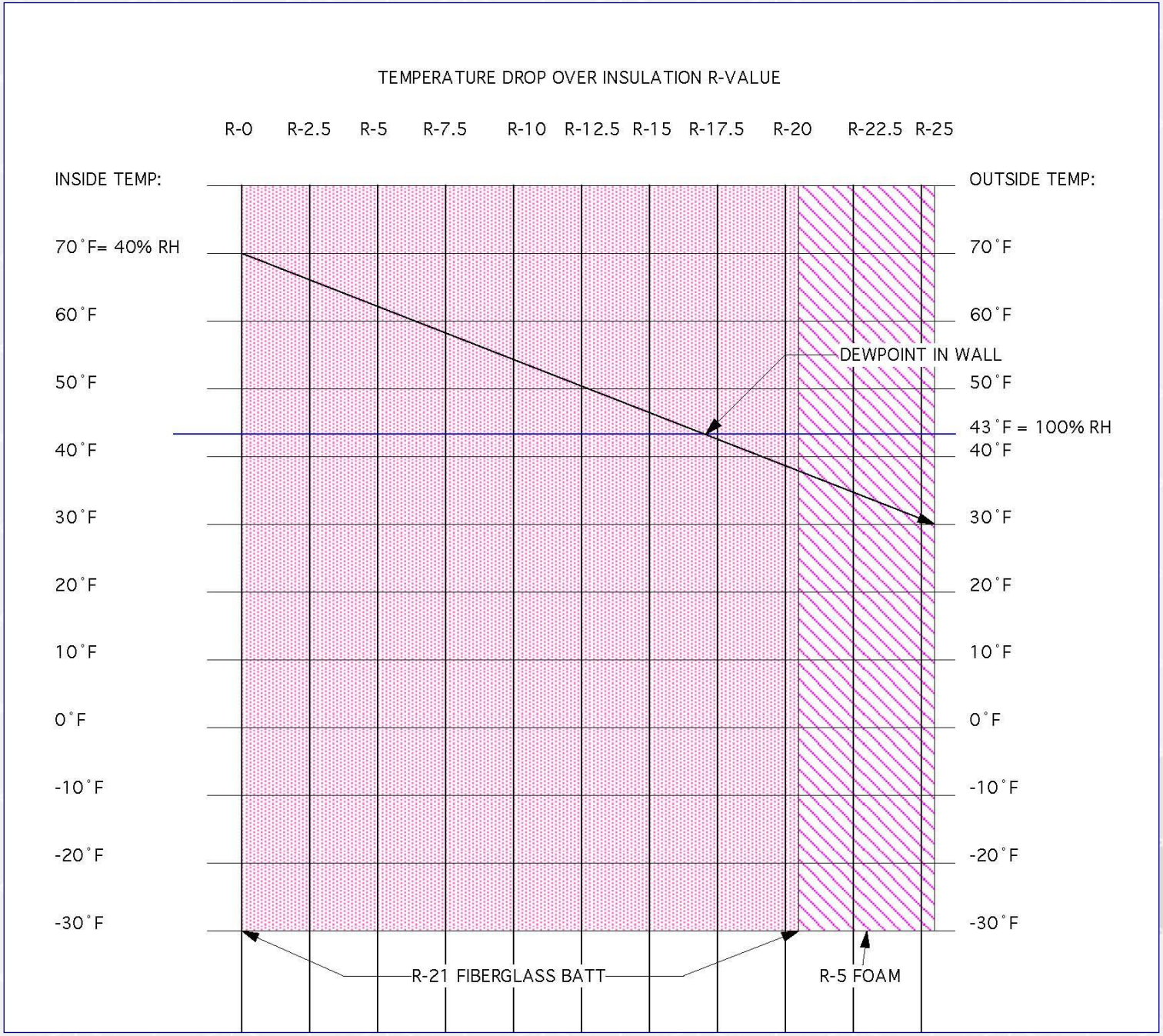


Image: buildingscience.com



Courtesy of Ted Clifton, Zero-Energy Plans LLC

Common Insulation Types - Pros/Cons

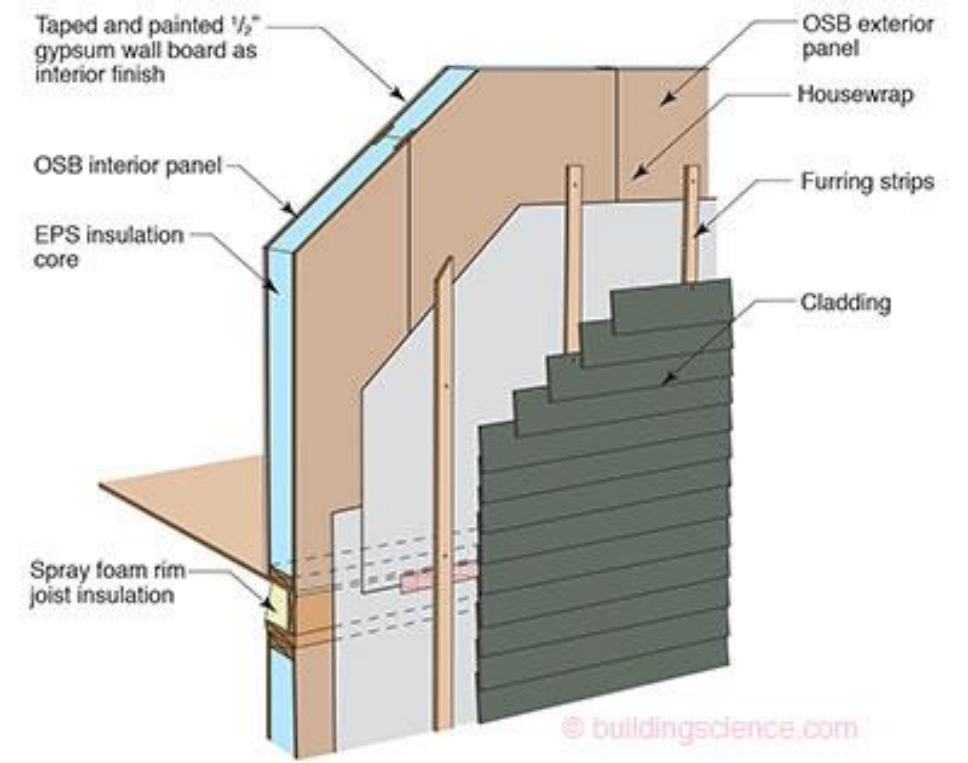
For All Insulation Types:

- Need understanding of performance characteristics to manage the risks

- Paying for proper **installation (Grade I)** – make sure that's what's installed!

Structural Insulated Panels (SIPS)

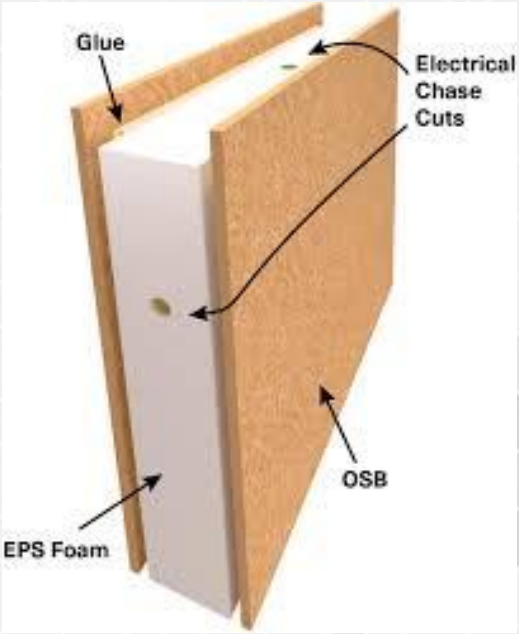
- Continuous insulation with minimum framing
- Up to 90% less air leakage compared to stick framing
- Standard size 4’x8’ but up to 8’x24’
- 4-1/2” to 12-1/4” thickness
- Roughly R-15 to R-44



Images: buildingscience.com

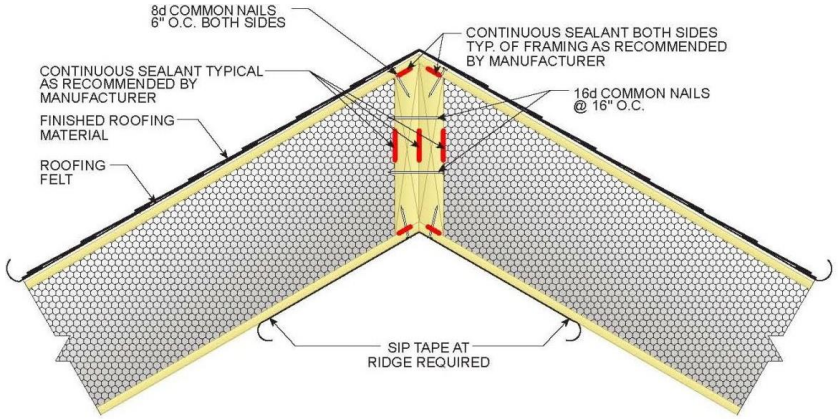
Structural Insulated Panels (SIPS)

- Ready to install when delivered to site
- Windows openings can be precut at the factory
- Quicker dry-in time
- Wire chases pre-drilled

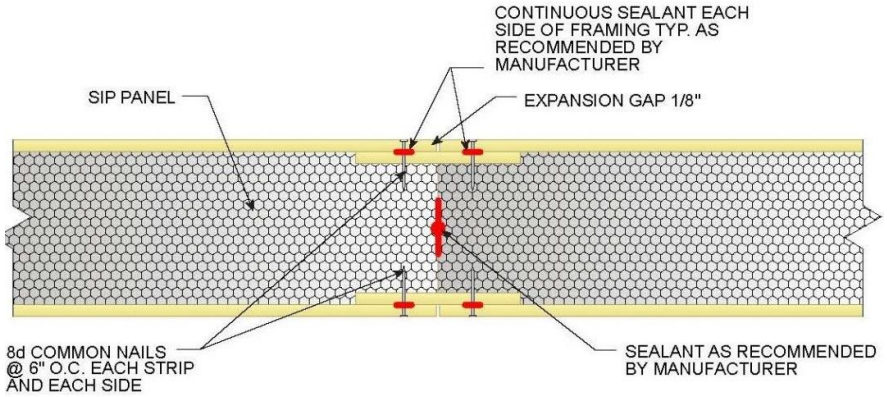


Images: enercept.com; acmepanel.com

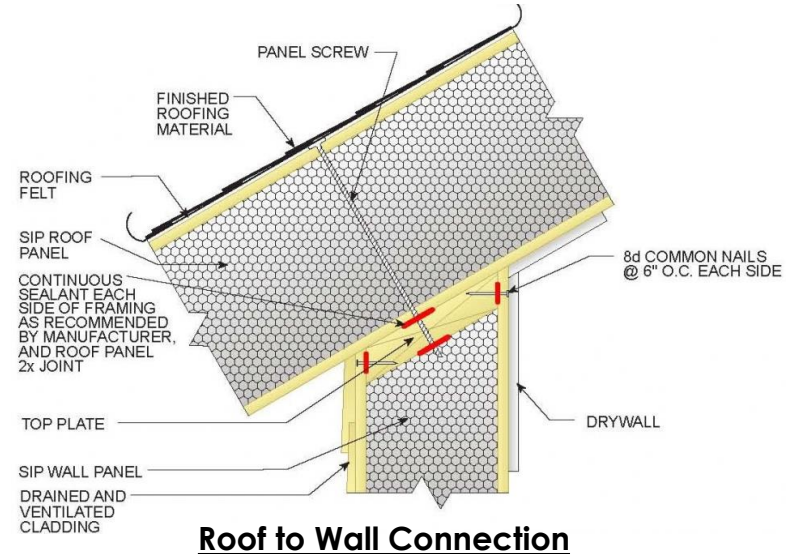
Structural Insulated Panels (SIPS) - Details



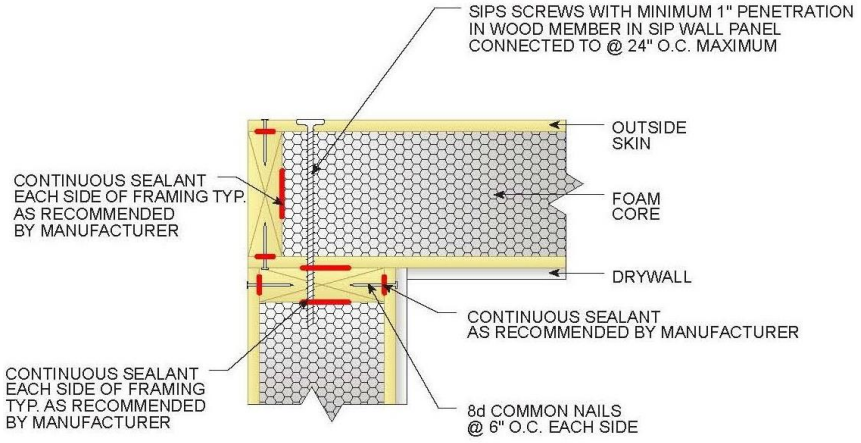
Ridge Connection



Horizontal Connection



Roof to Wall Connection



Exterior Corner Connection

Images: pinterest.com

Blower Door Testing

- A blower door test should be done regardless of local code requirements
  - ANSI/RESNET/ICC 380
  - Conducted at rough-in or final
  - You only get one chance to build the envelope right!
- A small cost but big liability protection
- Cannot properly size the HVAC system without knowing air leakage
- Easy and quick – typically have the report in less than an hour

Images: prosoco.com

HVAC Right Sizing

- Right sizing HVAC means finding the appropriate equipment size for the house as built
- Keep system components within conditioned space!
- *Manual J* report should be used as basis of your request for bid from the HVAC contractors
  - Request calculations from HVAC contractor
  - Only a few hundred dollars and lowers liability risks and call-backs
- **Verify** as-built envelope and calculation inputs match
- **Verify**/commission system installation

A monster truck might work as a family vehicle but it's not optimal!

Image: salemnews.net

Best Practice for Selecting HVAC Equipment

- ACCA Manual S
- Selection must consider:
  - Fuel sources
  - Distribution mechanisms
  - Equipment options
  - Equipment efficiency
- Life cycle analysis considers:
  - Equipment and installation prices
  - Annual heating and cooling expense
  - Maintenance costs

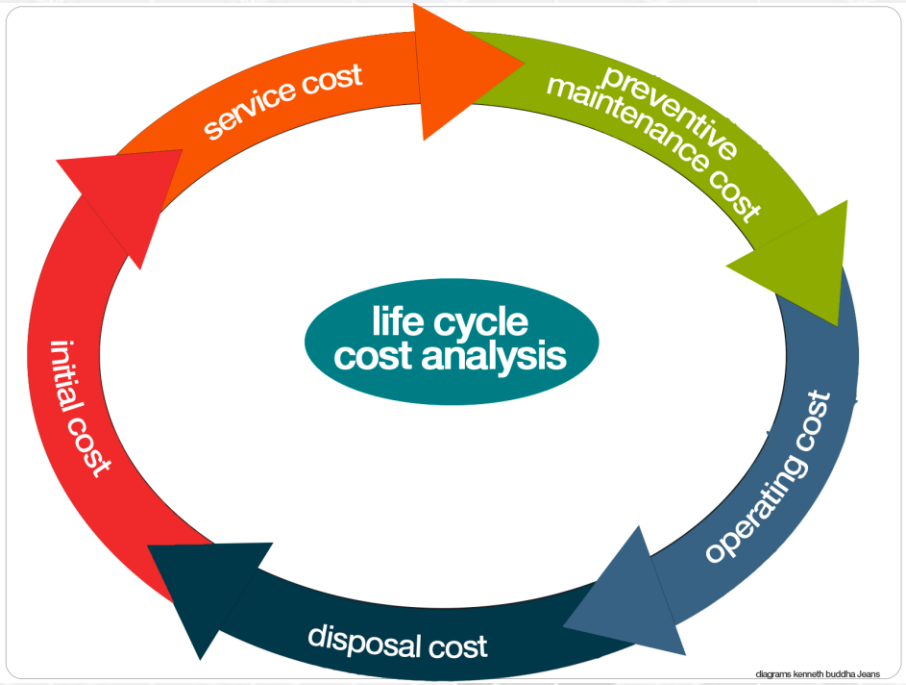


Image: educationviews.org

Duct Design and Layout

- Do not use building cavities for supply or return. Period.
- Request ACCA Manual D design and calculations from HVAC contractor
- Verify all ducts, plenums, take-offs, boots, etc. are sealed – regardless of location
- Request test and balance report and verify with design

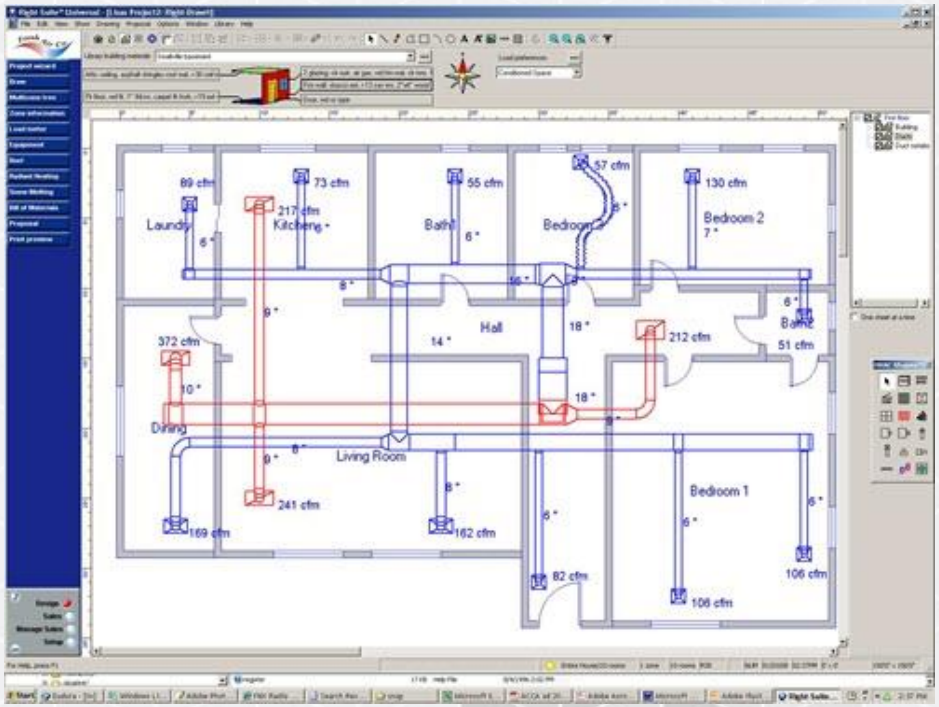


Image: wrightsoft.com

Homeowner Training

- HVAC filters
- Thermostat operations
- Lighting controls
- Appliances
- Hot water
- Recycling practices & locations

Images: sprecycling.com; homelectrical.com

Building Practices

- Maintenance checklist
- Recycling programs
- Utility programs
- Energy-efficient lighting
- Water and energy conservation
- Public transportation
- Valves and controls
- Maintenance services
- Photo record of utilities
- Hazardous materials
- Organic products
- Landscaping
- Relative humidity
- Termites
- Gutters and downspouts
- Narrative
- Stormwater management

How to Improve Quality Control? Checklists!

Checklists:

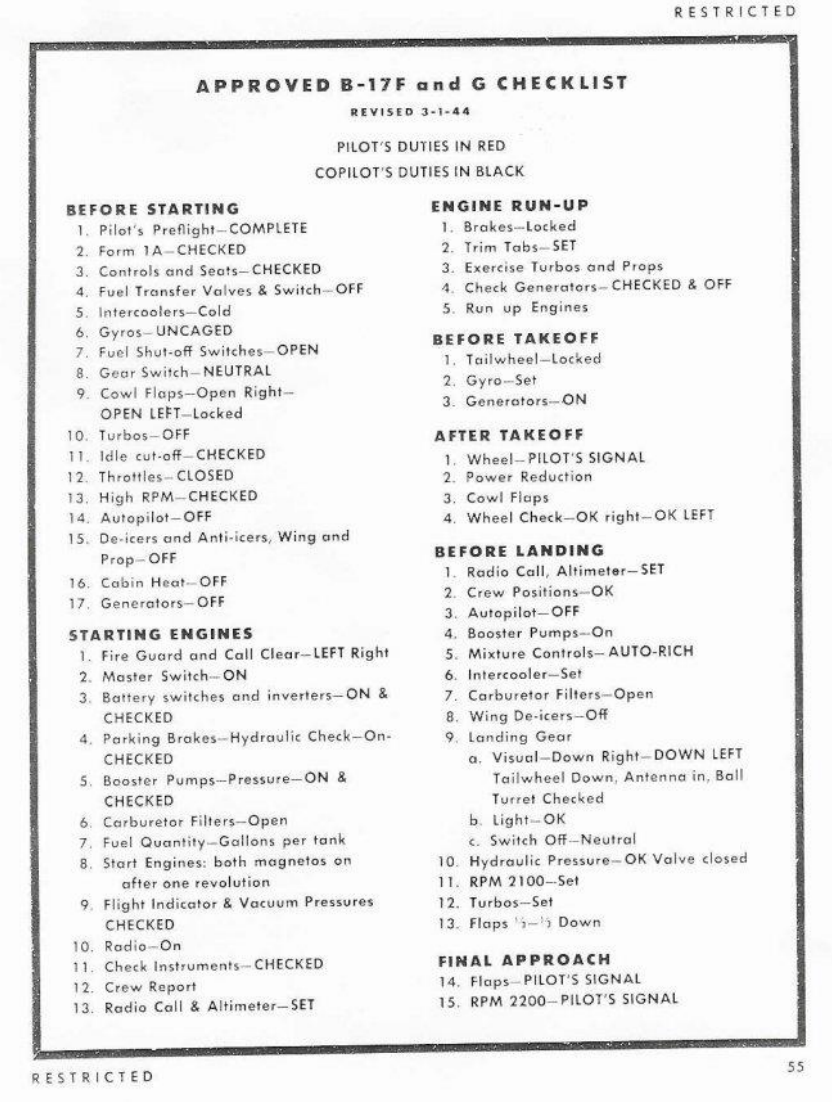
- Eliminate the gap between Potential and Application
- Identify the “known unknowns” ahead of time so they can be dealt with!

Image: grad.tamu.edu

They Provide:

- Guidance
- Compliance with schedule
- Documentation of critical items after cover.
- Liability Protection

Checklists



RESTRICTED

APPROVED B-17F and G CHECKLIST

REVISED 3-1-44

PILOT'S DUTIES IN RED

COPILOT'S DUTIES IN BLACK

BEFORE STARTING

1. Pilot's Preflight—COMPLETE
2. Form 1A—CHECKED
3. Controls and Seats—CHECKED
4. Fuel Transfer Valves & Switch—OFF
5. Intercoolers—Cold
6. Gyros—UNCAGED
7. Fuel Shut-off Switches—OPEN
8. Gear Switch—NEUTRAL
9. Cowl Flaps—Open Right—OPEN LEFT—Locked
10. Turbos—OFF
11. Idle cut-off—CHECKED
12. Throttles—CLOSED
13. High RPM—CHECKED
14. Autopilot—OFF
15. De-icers and Anti-icers, Wing and Prop—OFF
16. Cabin Heat—OFF
17. Generators—OFF

STARTING ENGINES

1. Fire Guard and Call Clear—LEFT Right
2. Master Switch—ON
3. Battery switches and inverters—ON & CHECKED
4. Parking Brakes—Hydraulic Check—On-CHECKED
5. Booster Pumps—Pressure—ON & CHECKED
6. Carburetor Filters—Open
7. Fuel Quantity—Gallons per tank
8. Start Engines: both magnetos on after one revolution
9. Flight Indicator & Vacuum Pressures CHECKED
10. Radio—On
11. Check Instruments—CHECKED
12. Crew Report
13. Radio Call & Altimeter—SET

ENGINE RUN-UP

1. Brakes—Locked
2. Trim Tabs—SET
3. Exercise Turbos and Props
4. Check Generators—CHECKED & OFF
5. Run up Engines

BEFORE TAKEOFF

1. Tailwheel—Locked
2. Gyro—Set
3. Generators—ON

AFTER TAKEOFF

1. Wheel—PILOT'S SIGNAL
2. Power Reduction
3. Cowl Flaps
4. Wheel Check—OK right—OK LEFT

BEFORE LANDING

1. Radio Call, Altimeter—SET
2. Crew Positions—OK
3. Autopilot—OFF
4. Booster Pumps—On
5. Mixture Controls—AUTO-RICH
6. Intercooler—Set
7. Carburetor Filters—Open
8. Wing De-icers—Off
9. Landing Gear
   a. Visual—Down Right—DOWN LEFT Tailwheel Down, Antenna in, Ball Turret Checked
   b. Light—OK
   c. Switch Off—Neutral
10. Hydraulic Pressure—OK Valve closed
11. RPM 2100—Set
12. Turbos—Set
13. Flaps ⅓—⅔ Down

FINAL APPROACH

14. Flaps—PILOT'S SIGNAL
15. RPM 2200—PILOT'S SIGNAL

RESTRICTED

55

- ✓Checklists eliminate missing important items or process steps
  - ✓Building Officials use checklists
  - ✓Pilots use checklists
  - ✓Surgeons use checklists
  - ✓Rocket scientists use checklists

- ✓***You can use a checklist too!***

Checklists

Residential Energy: Architectural Plan Review Checklist					
Information on Construction Documents					
☐	A continuous building thermal envelope is represented on the construction drawings				
☐	Typical cross sections clearly indicate insulation R-value, type, and material for each unique assembly type				
☐	Compliance path is clearly noted on the plans or accompanying documentation. Otherwise, assume prescriptive.				
☐	Notes indicate the *Air Barrier and Insulation Installation Checklist* will be completed by an approved party				
☐	Notes indicate the *Duct and Envelope Testing Certificate* will be completed by an approved party				
Indicate the compliance path selected by the applicant and complete the appropriate section below					
☐ Prescriptive	☐ Total UA (RES*check*)	☐ Performance	☐ Energy Rating Index	☐ Above Code Program	
Prescriptive Path (with no tradeoffs)					
☐	R-values and U-factors on plans meet Table 402.1.2 for Climate Zone 4 for each assembly				
Total UA Alternative: RES*check* Reports					
☐	Compliance field says "PASSES"				
☐	Verify correct code edition				
☐	Address matches the plans				
☐	REScheck version 4.6.5 or higher				
☐	Each unique assembly type is listed (including cantilevered floors, floors over garages, and bump-out ceilings)				
☐	Listed R-values and U-factors match plans				
☐	Cavity insulation R-values are not listed in the Continuous R-value column				
☐	Signed by the person completing the report				
Simulated Performance Alternative Reports					
☐	For IRC-scope buildings, 2015 IECC Performance Report is present				
☐	For IBC/IECC [RE] buildings, 2018 IECC Performance Report is present				
☐	Annual Energy Cost of Design Home ≤ IECC Home in the "SubTotal – Used to Determine Compliance" line (Note: Report may fail, provided the only non-compliant item is the *Home Infiltration Check* and the design infiltration value is ≤ 5.0 ACH50)				
☐	Energy Code Inspection Checklist is present				
☐	Report contains the name of the individual completing the report				
☐	Report contains the name and version of the software tool (REM/Rate or Ekotrope)				
☐	Address matches the plans				

Image: paenergycode.com

Review Questions – Session 6

What are two of the important components of the building envelope and related practices that are critical to achieving energy conservation in a structure?

A. Air barrier, Thermal Barrier

B. Moisture Barrier, Energy Barrier

C. Windows, Doors

D. Framing, Testing

Review Questions – Session 6

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Review Questions – Session 6

Why is Home-Owner Training Important?

A. Using new technologies and materials can generate new risks.
B. Using old technologies in new and inappropriate ways can cause problems.
C. Lack of proper maintenance can surface later as alleged construction defects.
D. All of the above.

Review Questions – Session 6

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NON-CODE STANDARDS

Non-Code Standards

- There are many, many non-code standards
- Minimum code standards still have to be met (code is the law)
- Specific requirements for meeting standards are above, beyond, or in addition to code minimum

Home Energy Rating System (HERS)

- HERS is a comparative residential energy rating system developed in 2006
  - http://www.resnet.us/energy-rating
- RESNET credentials HERS Raters who provide the home rating
- HERS score rates home energy features, including appliances
  - Can be used for **new or existing** homes
    - 100 = meets 2006 IECC
    - 0 = zero energy home
  - **Rating does not address all code requirements**
    - Mandatory requirements must still be met
    - Energy Rating Index (ERI)

RESNET HERS® INDEX

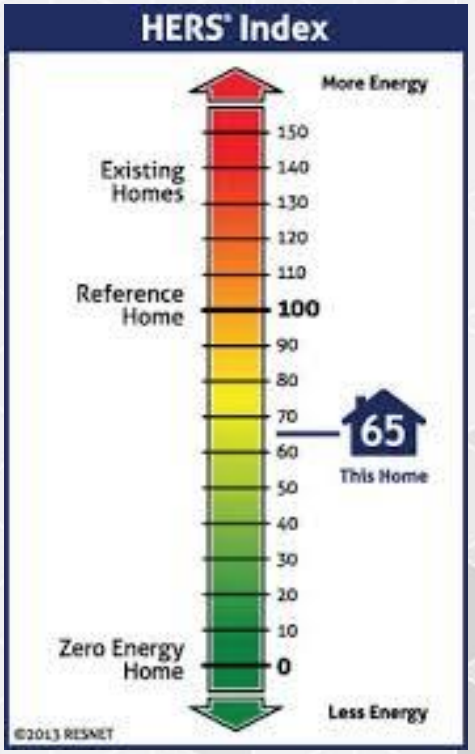


Image: hersindex.com

Energy Star

- Federal "**above code**" program for new homes
  - Specific requirements must be met
  - energystar.gov/newhomes?s=mega
- Focuses on
  - Efficient HVAC
  - High performance thermal envelope
  - **Moisture control**
  - Efficient lights and appliances
- Independent **testing and verification** of homes
- Higher appraised home value

Image: smartenergy-form.arch.Illinois.edu

LEED for Homes

- Leadership in Energy and Environmental Design (LEED)
  - Developed by the US Green Building Council (USGBC)
  - **Energy and sustainability**
  - Commercial and residential
  - new.usgbc.org/leed
- LEED for Homes is a voluntary rating system that promotes the design and construction of high-performance green homes
  - Also LEED designations for multi-family
- Credentials professionals and certifies buildings

Images: usgbc.org

LEED for Homes

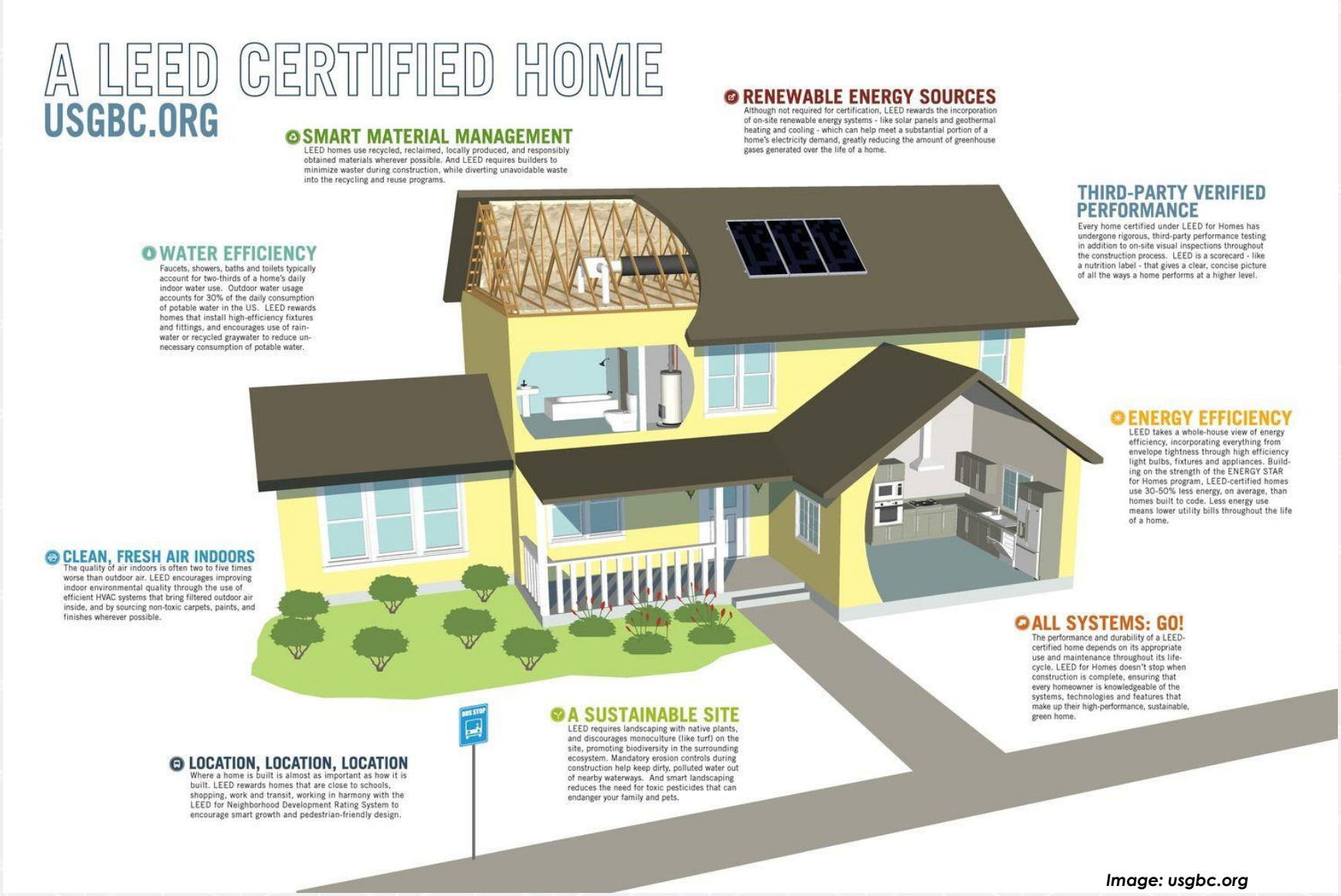
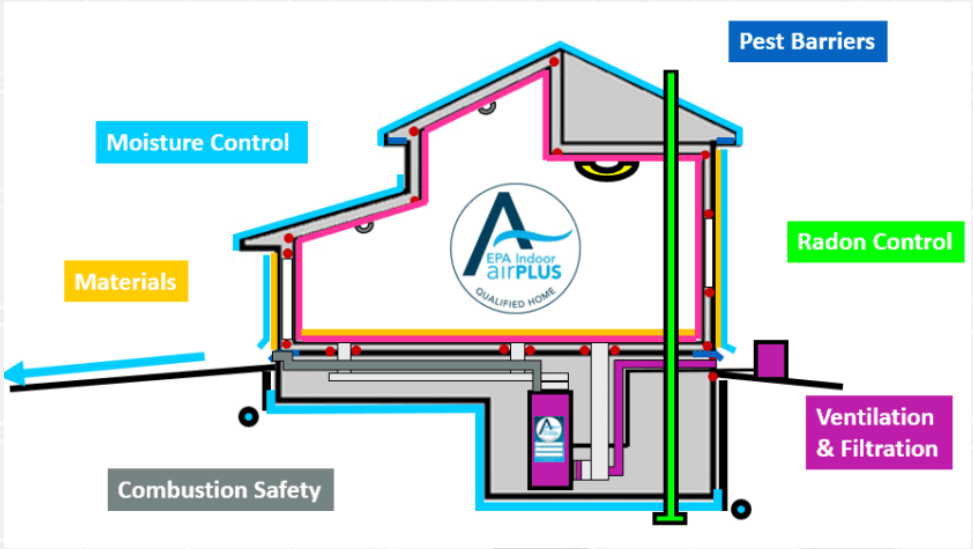


Image: usgbc.org

EPA Indoor airPLUS

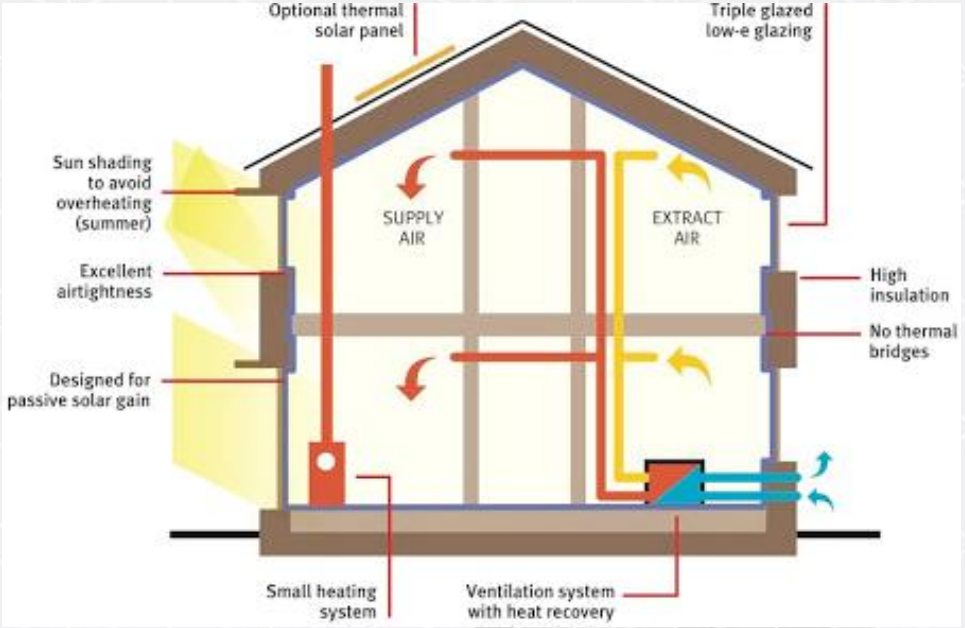
- A **voluntary EPA program** helping builders improve indoor air quality
  - epa.gov/indoorairplus
- Home must first be designed to meet **Energy Star certification**
- Then home must meet requirements for
  - HVAC system and moisture control
  - **Combustion pollutants**
  - Low VOC materials
  - Radon



Images: epa.gov

Passive House

- A rigorous voluntary standard focused on a tight thermal envelope, **ultra-low energy use**, and fresh, filtered air
  - phius.org/home-page
  - passivehouse.com/
- Follows a set of design principals that **optimizes** heat gains and losses
- Certifies both design professionals and builders
- Approach can be use for both residential and commercial buildings



Images: johngilbert.co.uk; phius.org

Zero Energy Ready Homes (ZERH)

- Formerly the Building America Builders Challenge
- Rigorous requirements that ensure outstanding levels of energy savings, comfort, healthy, and durability
  - energy.gov/eere/buildings/zero-energy-ready-homes
- Verified by a qualified third-party
- 40%-50% more energy efficient than a typical new home.
- Both prescriptive and performance compliance paths

Image: energy.gov

Active House

Image: activehouse.info

- Started in Europe (Based in Brussels)
- Focuses on how indoor environment affects productivity, health, and well being
- Includes requirements for daylighting, IAQ, sound, energy, water, and sustainable construction
- Assistance in engineering and specification
- Emphasis on electric power

Other Standards

- ***WELL:*** seeks to develop buildings that enhance health and wellness
  - wellcertified.com/about-iwbi
- ***Living Building Challenge****:* Sustainable design framework with no carbon burning equipment
  - living-future.org
- ***ICC 700-2020:*** National green building standard includes high performance standards for Lot Development, Energy, IAQ, Water, and Operations
  - https://www.iccsafe.org/building-safety-journal/bsj-hits/2020-national-green-building-standard-now-available-for-free-download/
- ***ASHRAE 90.2-2018:*** seeks to deliver energy performance at least 50% more efficient than the 2006 IECC
  - ashrae.org/news/esociety/newly-revised-standard-90-2-includes-new-performance-specifications-more

Key Takeaways

- Communication is essential to ensuring a well-constructed building
- Understanding building science and best practices is important and will make sure your buildings are constructed well, regardless of what the code requirements are
- There are many standards that can be used as a guide to build beyond the requirements in the code

Questions?

- Unmute yourself to ask a question or enter questions/comments into the chat

Review Questions – Session 6

What is the best way to maintain consistency in the Building Process and eliminate the “Known Unknowns”?

A. Use a Comprehensive Checklist

B. Do it “the way we’ve always done it!”

C. Blower door test

D. Use the same superintendent throughout

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What is a Benefit of using a Non-Code (Above Code) program?

A. You get “Bonus Points” during your inspections.
B. They serve as a guide to use advanced systems and or technologies.
C. Your home goes up in price.
D. To make your “standard code compliant” neighbors jealous.

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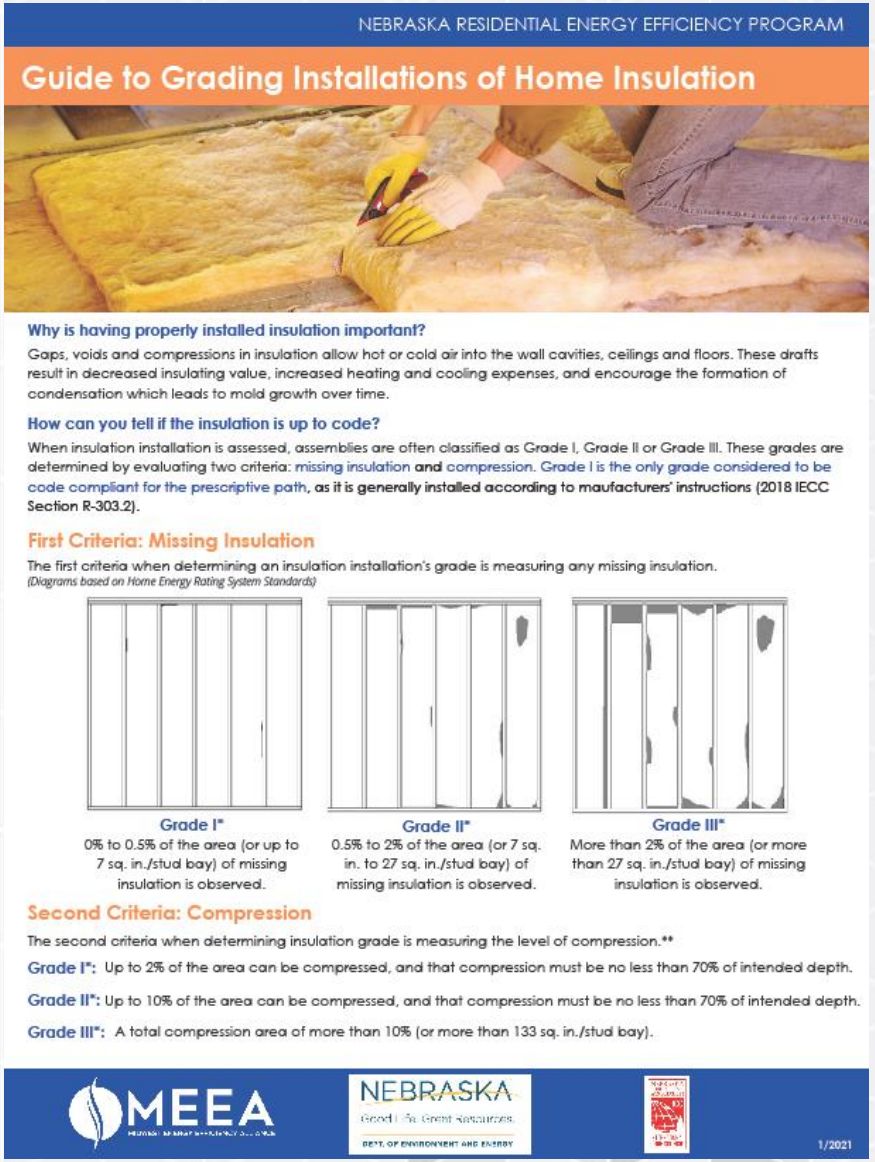
Resources

- Handouts on specific topics
  - Insulation installation
  - **HVAC Right Sizing**
  - Others coming soon
- Made to share with Trades/Subs, etc.
- Visit: https://www.mwalliance.org/metropolitan-community-college-energy-code-course



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 NEBRASKA 1/2021

Continuing Education Credits

- Participants of this session are eligible for continuing education credits from the International Code Council

- Course ID: **27512**
- CEUs: **0.2**

- If you would like a certificate of completion for this session, email Nicole at nwestfall@mwalliance.org

Next Week

- March 9, 2021, 6:30-8:30pm
- Topic: Advanced Building Efficiency Technologies
- Contact Matt with Questions: matt@verda-solutions.com

Matt Belcher

matt@verda-solutions.com

SEE YOU NEXT WEEK!