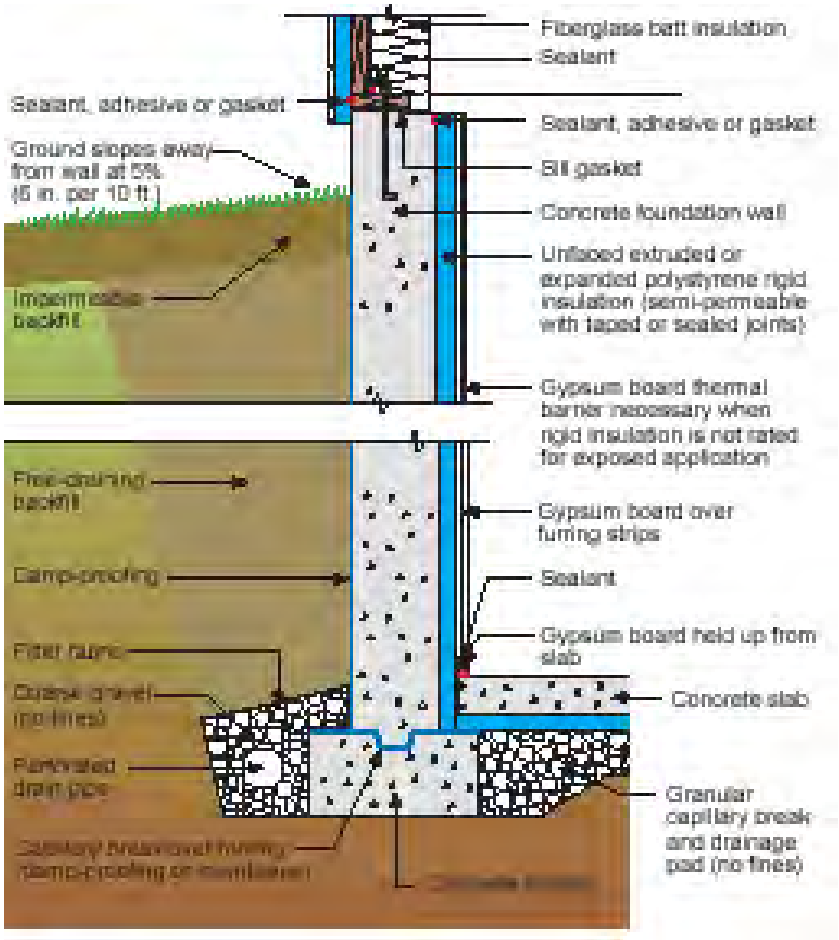
Reality of Underfloor Insulation

Insulating Basements

www.eeba.org
www.buildingscience.com



Systems Approach to Walkout Basements

Advantages to insulating *all* basement walls:

- Wall insulation lasts longer and works well (R-10 wall in CZ4 vs. R-19 floor)
- Ducts and AHU are brought inside envelope
- Main floor level is more comfortable
- Basement may be finished or unfinished

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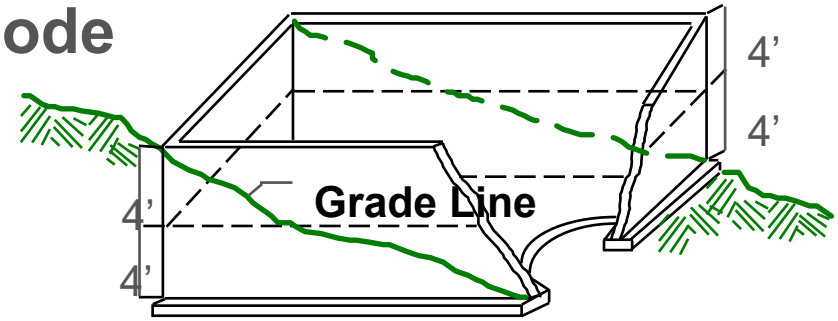
Definition and Prescriptive Code

- Basement Wall: Average gross wall must be > 50% below grade and enclose conditioned space
- CZ4-5: R-10 continuous or R-13 cavity
  - 2018 CZ5=R-15/19

Try to avoid cavity insulation; continuous insulation performs better



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Interior Insulation Strategies

Cellulose blanket/batt

Rigid foil-faced poly-iso foam board

Fiberglass batt w/ vinyl backing

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Interior Insulation Strategies

Rigid foam board

Fiberglass batt in AGW, foam board on concrete

Spray Polyurethane Foam

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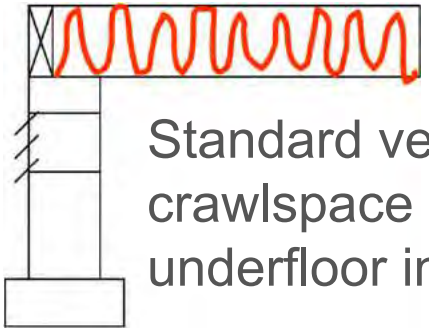
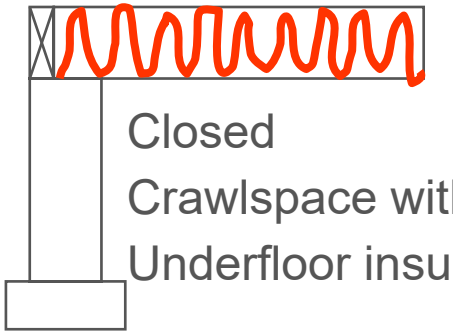
Interior Insulation Strategies

Blanket Basement Insulation Options

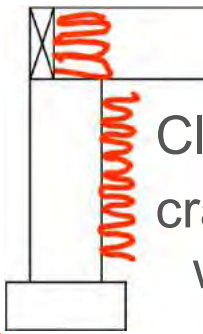
R402.2.11 Crawlspace Walls



Standard vented crawlspace - underfloor insulation



Closed Crawlspace with Underfloor insulation



Closed crawlspace with wall insulation

- **Note**: all crawspaces must meet vapor retarder requirements, as per IRC (exception for open crawlspaces)

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R402.2.11 Crawlspace Walls

- Seal ground with 6-mil plastic (6” up walls, 6” overlaps)
- Insulate interior of walls to satisfy code (R-10 in CZ4, R-15 in CZ5)
- Eliminate all vents and leaks (access doors)
- Satisfy IRC exception to vent requirement (IRC section R408.3)

Venting Exceptions:

- Continuous exhaust (radon)
- Direct condition crawlspace (supply)
- Direct condition (dehumidifier)

Critical Details:

- No drainage problems
- Use a sealed combustion / direct vent furnace or install a Heat Pump
- Pest Control and Code Official awareness

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Insulation techniques – Walls

www.crawlspaces.org

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Insulation techniques – Band area

Open/
Closed
Cell Foam

Caulk and
Fiberglass
Batt

- Must air seal and insulate rim/band area in basements & crawlspaces

Blown
Bag /
Pillow

- Pest Control industry struggles with band area fully filled with SPF
- SPF that fills band blocks inspection for pest control
- Air seal and then insulate with movable insulation product (batts, pillows, rigid board, etc.)

The band-joist area can be a challenge to insulat correctly, with some contractors opting for fiberglass batt rather than the complications of spray foam. For installers working with blown fiberglass or cellulose, National Fiber offers another option. Its Insul-Cube is a fire-rated bag can be filled with blown insulation on-site, then friction-fit between the joists. The amount of insulation used will vary according to the size of the space, and the cubes can be filled-in-place behind pipes or wires. National Fiber |

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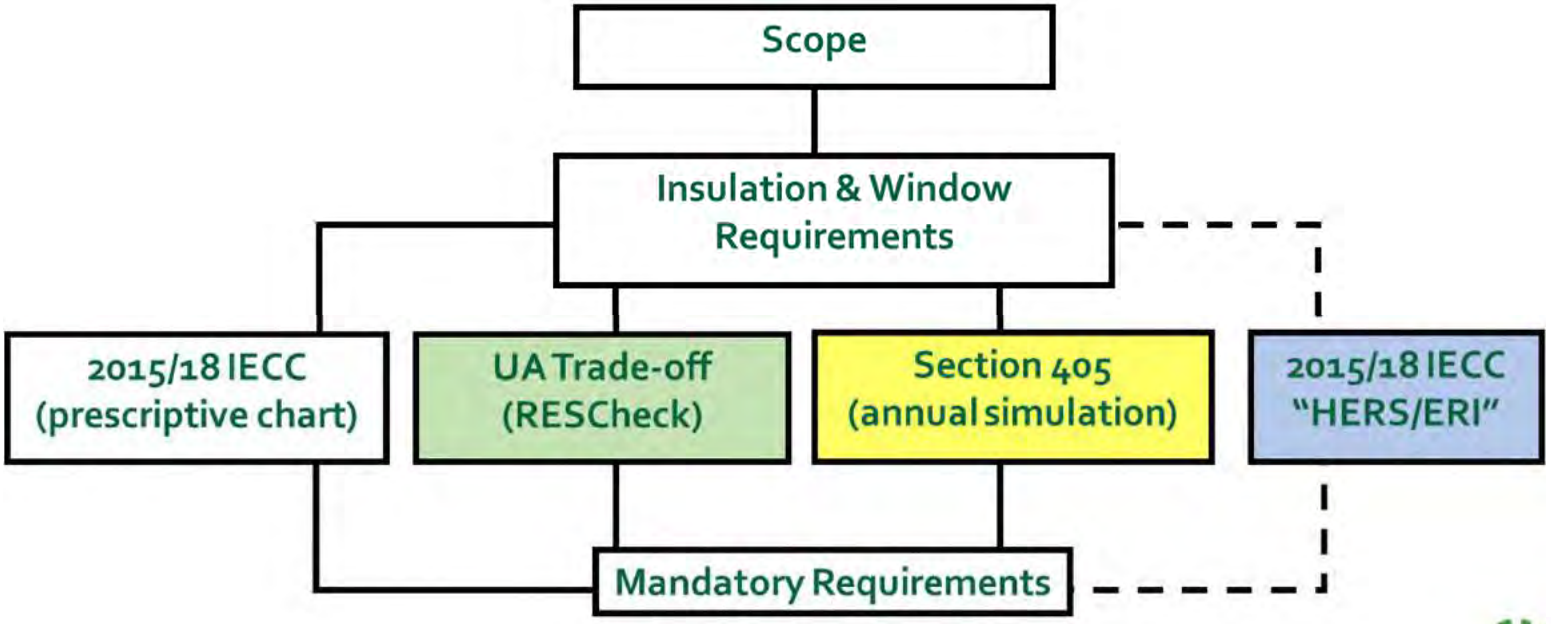
Envelope Tradeoff Options



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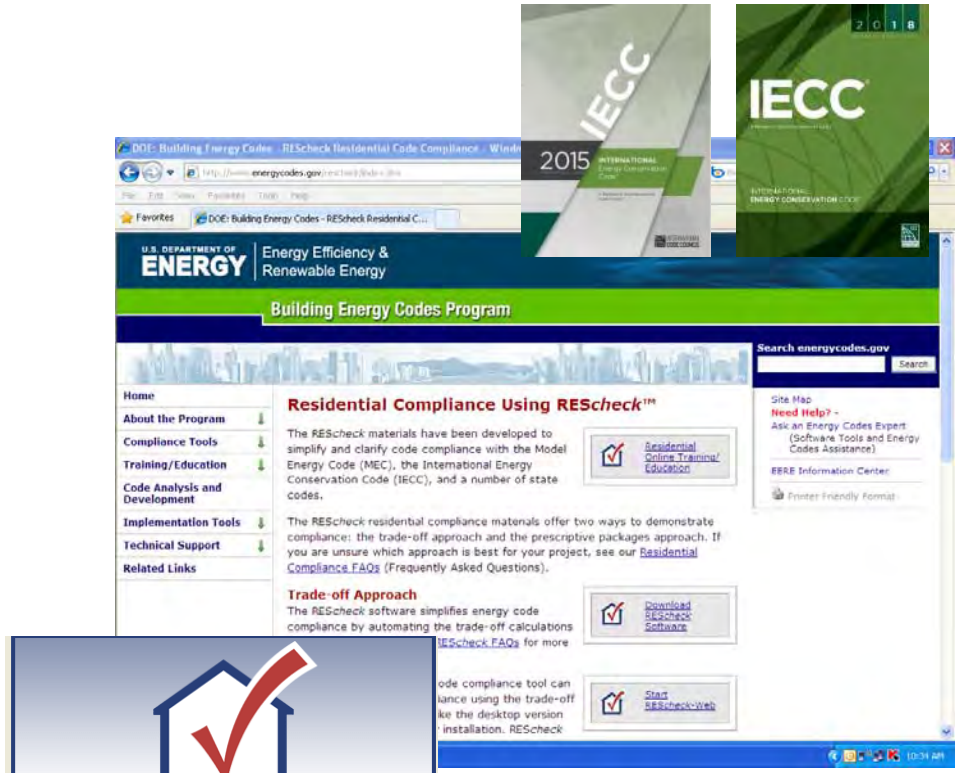
RECcheck Tradeoff Option

- www.energycodes.gov
- Software evaluates specific designs quickly
- Demonstrates SHGC compliance
- Allows trade-offs
  - Building envelope components
  - No trade-offs for better heating & cooling equipment efficiencies
- Specify code edition



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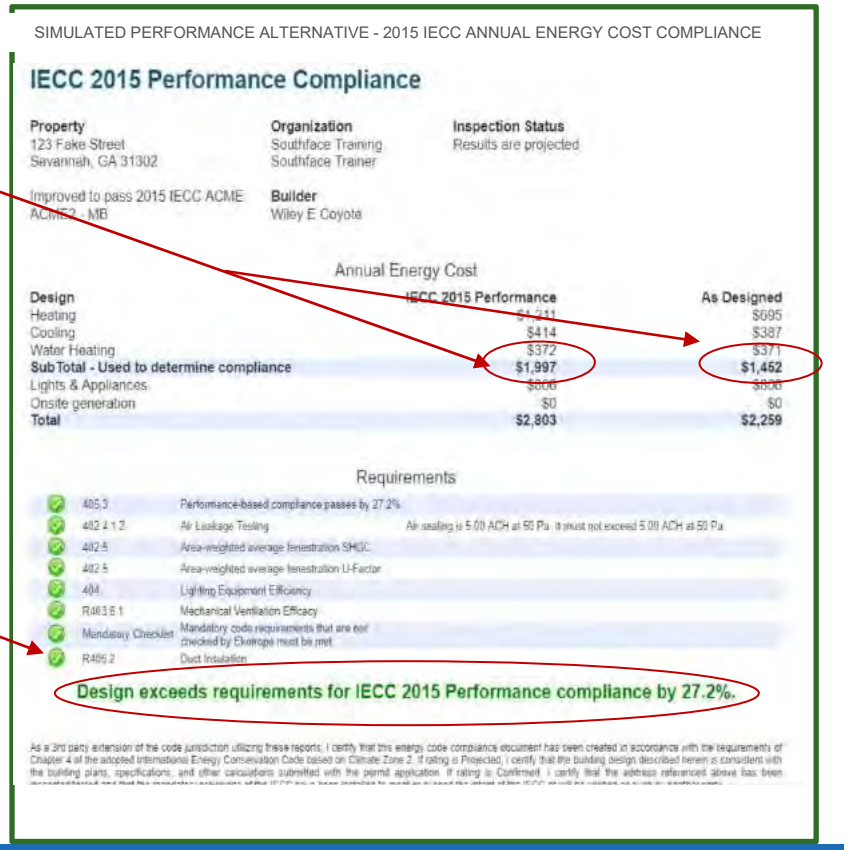
Section 405 Simulated Performance Alternative - Sample Report

- Annual energy usage simulation demonstrates that the proposed building's energy costs are ≤ "standard code" building
- No credit for mechanical efficiencies
- Likely to involve a HERS rater
- Ekotrope, REMrate & Energy Gauge are acceptable

- Compares total annual energy costs
  - Window U-factor and SHGC
  - Envelope and duct testing
  - Lighting, duct insulation
- Compares energy costs of actual home being built against 2015/18 IECC reference home's energy cost



SIMULATED PERFORMANCE ALTERNATIVE - 2015 IECC ANNUAL ENERGY COST COMPLIANCE

IECC 2015 Performance Compliance

Property	Organization	Inspection Status
123 Fake Street Sevannah, GA 31302	Southface Training Southface Trainer	Results are projected

Improved to pass 2015 IECC ACME
ACME2 - MB

Builder
Wiley E Coyote

Annual Energy Cost

Design	IECC 2015 Performance	As Designed
Heating	$1,211	$695
Cooling	$414	$387
Water Heating	$372	$371
SubTotal - Used to determine compliance	**$1,997**	**$1,452**
Lights & Appliances	$806	$806
Onsite generation	$0	$0
Total	**$2,803**	**$2,259**

Requirements

405.3	Performance-based compliance passes by 27.2%	
402.4.1.2	Air Leakage Testing	Air sealing is 5.00 ACH at 50 Pa. It must not exceed 5.00 ACH at 50 Pa.
402.5	Area-weighted average fenestration SHGC	
402.5	Area-weighted average fenestration U-Factor	
404	Lighting Equipment Efficiency	
R403.5.1	Mechanical Ventilation Efficacy	
Mandatory Checklist	Mandatory code requirements that are not checked by Ekotrope must be met	
R405.2	Duct Insulation	

Design exceeds requirements for IECC 2015 Performance compliance by 27.2%.

As a 3rd party extension of the code jurisdiction utilizing these reports, I certify that this energy code compliance document has been created in accordance with the requirements of Chapter 4 of the adopted International Energy Conservation Code based on Climate Zone 2. If rating is Projected, I certify that the building design described herein is consistent with the building plans, specifications, and other calculations submitted with the permit application. If rating is Confirmed, I certify that the address referenced above has been

Energy Rating Index (ERI) path

The ERI may allow more options in materials choice, technologies and innovative strategies than the simulated performance path

- The new Energy Rating Index (ERI) path gives the most design flexibility (e.g., credit for mechanical equipment efficiency)
- It also credits items not covered by the code (e.g., appliance efficiencies)

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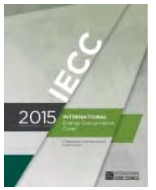
How is the ERI determined?

- The ERI is a numerical integer value
- Lower index numbers indicate lower energy use
- The HERS Index is currently accepted for use as the ERI
- A HERS Index is generated from a HERS Rating using modeling software (e.g., Energy Gauge, REMRate, Ekotrope)
- HERS stands for *Home Energy Rating System*



RESNET HERS® INDEX

HERS was developed by the Residential Energy Services Network (RESNET)

www.resnet.us

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Determining the Energy Rating Index

1. Simulate two homes
   - ***Rated*** Home – what will be built
   - ***Reference*** Home – same home but exactly meets '06 code
2. Compare Annual Energy
   - Space Heating & Cooling, Hot Water, Lighting and some Appliances
   - Multiply by 100 (lower w/ renewables)

Index = 100 x $PE_{fraction}$ x $\frac{\text{[}\textbf{\textit{Rated}}\text{ Home's Htg + Clg + WtrH + L.A.]}}{\text{[}\textbf{\textit{Refer}}\text{. Home's Htg + Clg + WtrH + L.A.]}}$ = **75**

40 30 30 50

70 20 30 80

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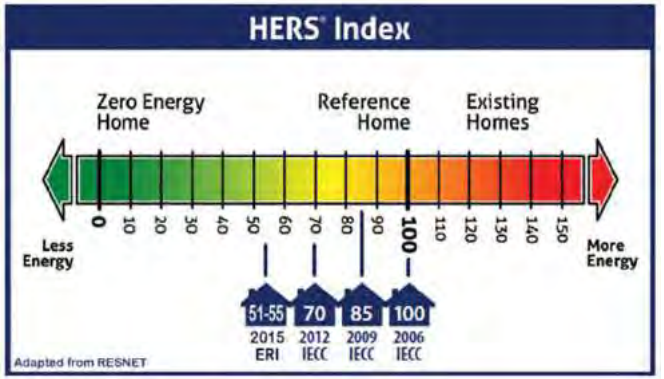
HERS / Energy Rating Index – What does it mean?

- HERS Index (lower is better)
- Rated home with Index of 100 = Reference home exactly meeting 2004/06 IECC
- Net Zero Energy Home = HERS Index of O



$$\textbf{Index} = 100 \times PE_{fraction} \times \frac{[\textbf{\textit{Rated}}\ \text{Home's Htg + Clg + WtrH + L.A.}]}{[\textbf{\textit{Refer}}.\ \text{Home's Htg + Clg + WtrH + L.A.}]} = \textbf{75}$$

40 30 30 50

70 20 30 80

$PE_{fraction}$ is ratio of renewables to purchased energy

(e.g, a home that produces 20% of its annual energy would have a $PE_{fraction}$ of 0.8)
In this example, 0.8 x 75 = **60**

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Energy Rating Index: Target Values

- The 2015/18 IECC sets a maximum ERI for each climate zone
- The ERI is not a “magic bullet” or “easy”
- However, it opens more options and allows builders more credit for innovative strategies (“*the ERI shall consider all energy used in the residential building*”)

TABLE R406.4
MAXIMUM ENERGY RATING INDEX

CLIMATE ZONE	ENERGY RATING INDEX	ENERGY RATING INDEX[a]
1	52	57
2	52	57
3	51	57
4	54	62
5	55	61
6	54	61
7	53	58
8	53	58

The rated design must have an ERI less than or equal to the above table to comply with 2015/18 IECC

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Summary of the Energy Rating Index

1. **2018 IECC targets**
   - Low 60's
2. **Who Can Do This?**
   - 3rd party – HERS Rater
   - Approved software
3. **Benefits**
   - Greater design flexibility
   - High efficiency equipment and appliances credited
4. **Backstops**
   - Envelope cannot be traded to be worse than 2009 IECC
   - Mandatory Requirements (air sealing, duct insulation, sealing, testing, etc.)

CLIMATE ZONE	ENERGY RATING INDEX[a]
4	62
5	61

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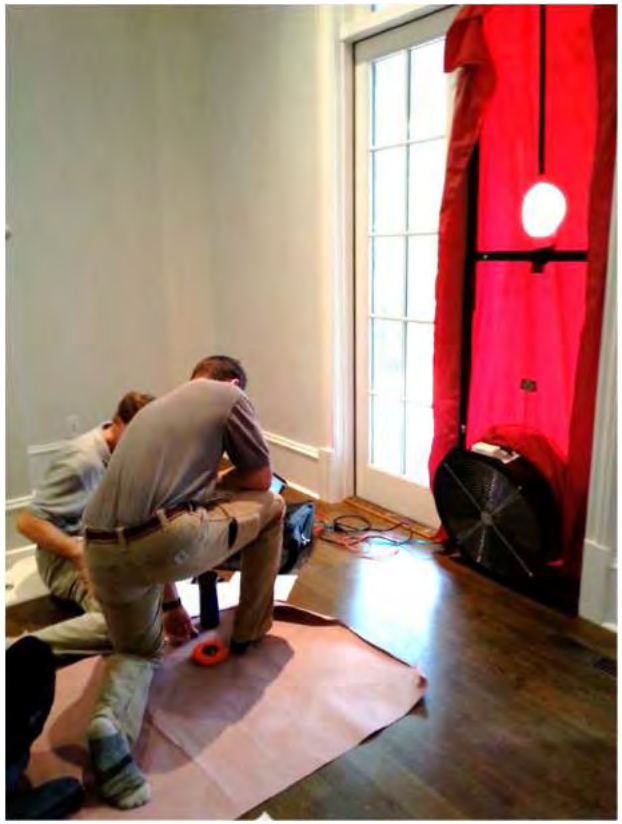
Blower Door Envelope Testing



- **IECC 2009 threshold: < 7 ACH50**
- **IECC 2012–18 threshold: < 3 ACH50**
- Quantifies the Amount of Leakage Across the Home's Thermal Boundary
- Should be administered by a Certified Professional (e.g., DET Verifier, BPI, HERS)
- Reported to Builder and Code Official via Certificate

$$ACH_{50} = \frac{CFM50 \times 60}{Volume}$$

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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
  = 567 sq. in.
- Divide by 144 to get ~**4 s.f.**

Southface Shortcut:

- Divide CFM_{50} by 1000
- *For example:*
  4,247 CFM_{50} / 1000
  = ~4.2 s.f.

How to Fail a Blower Door Test

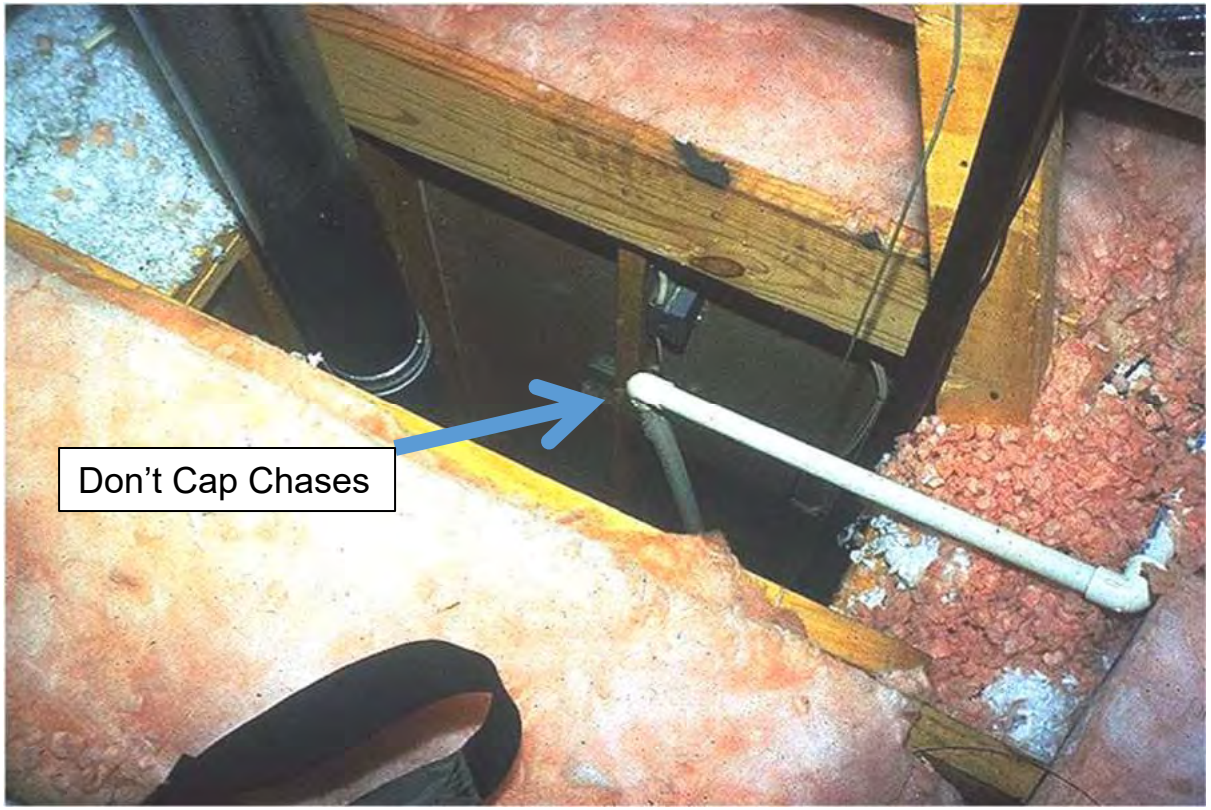
How to Fail a Blower Door Test

How to Fail a Blower Door Test

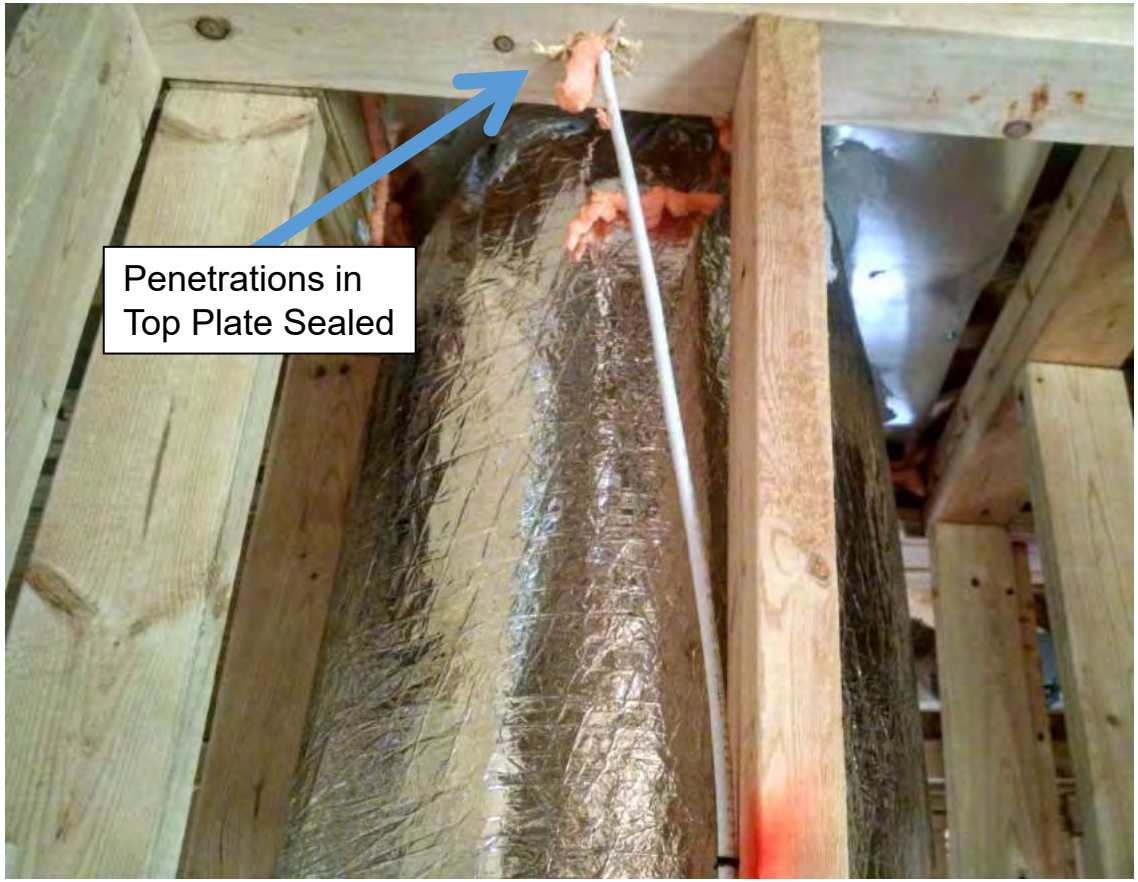
How to Fail a Blower Door Test

How to Fail a Blower Door Test

How to Fail a Blower Door Test



Air Sealing: Best Practices

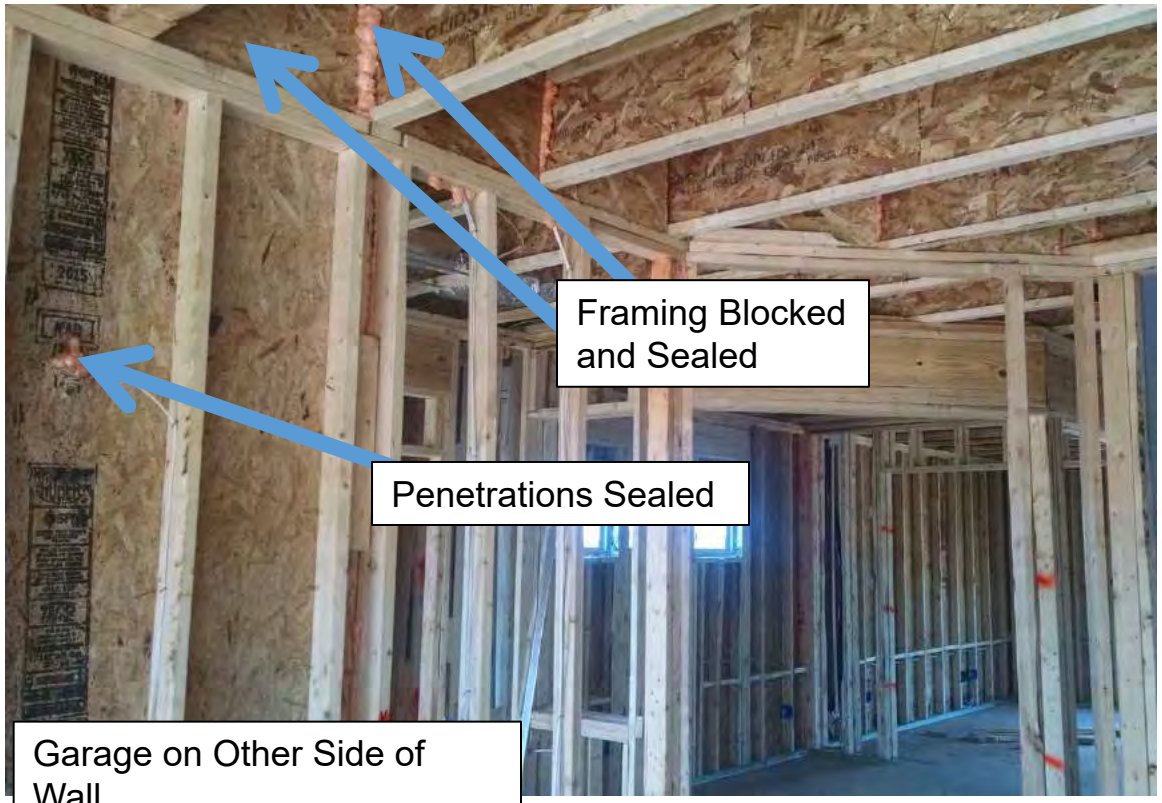


Chases

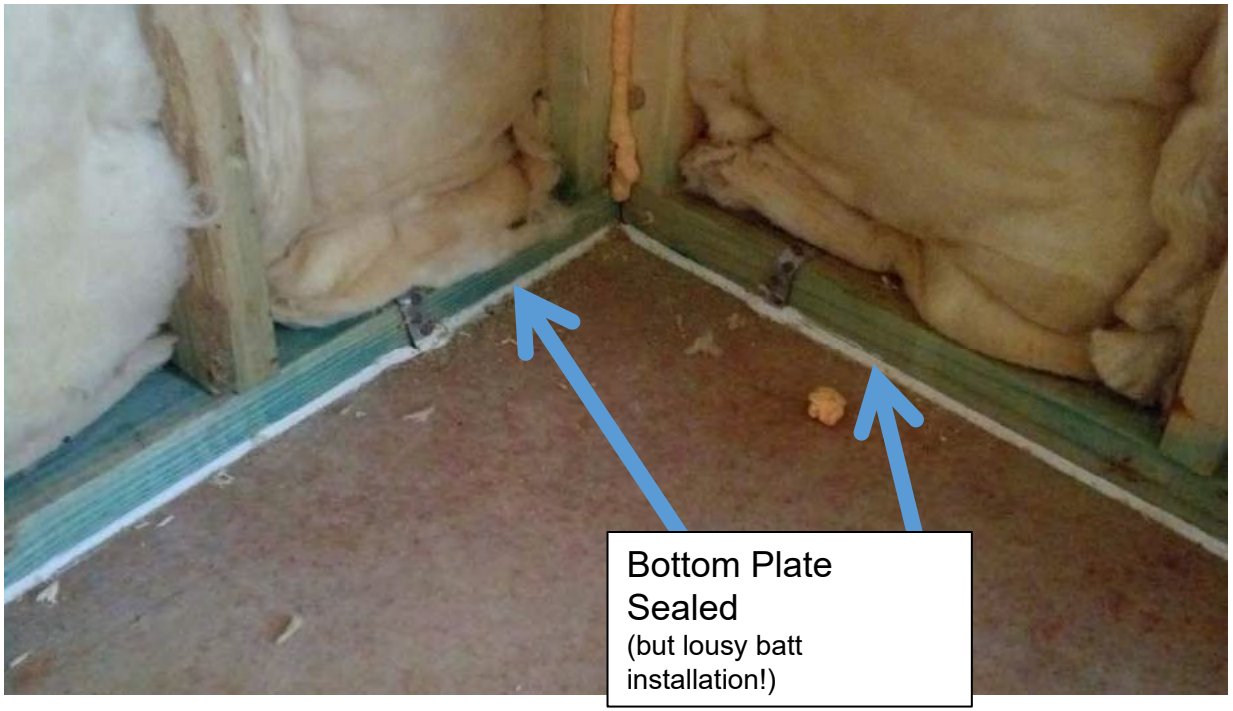
Chase capped and sealed around duct

Tubs

Framing & Penetrations



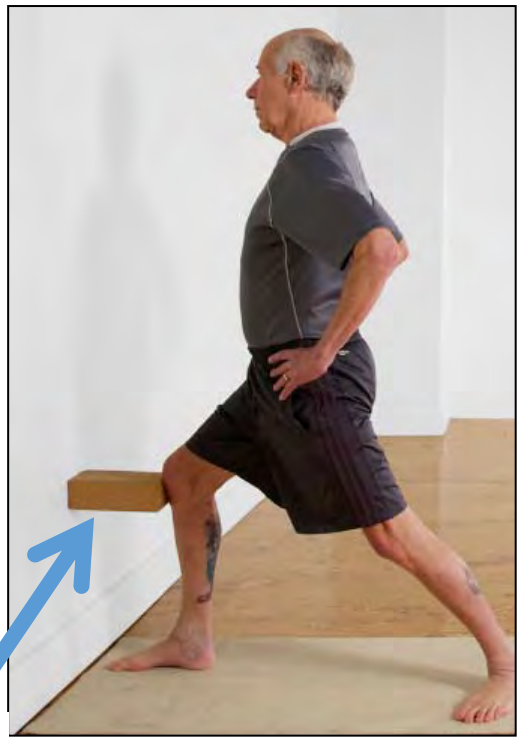
Bottom Plate



Kneewall Blocking

Install Kneewall Blocking

Not This!



Installing Insulation

- Voids / Gaps
- Compression / Incomplete Fill

Continuous Insulation & Air Barrier

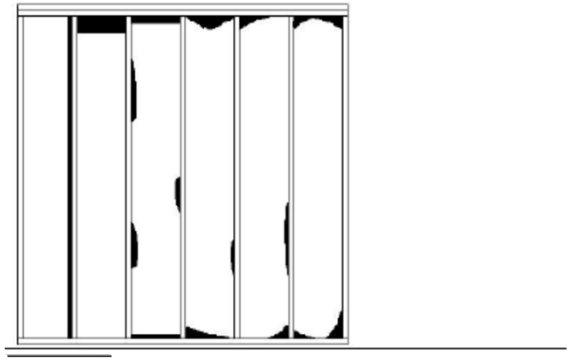
- Building Thermal Envelope
  (air barrier and insulation must be in contact)

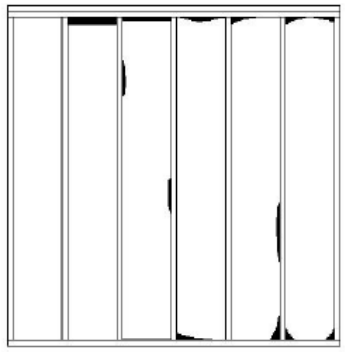
What's Wrong with This Picture?

Insulation Installation: Grade I, II, or III

- Unless verified, assume Grade III (worst) – see RESNET Appendix A-11-16

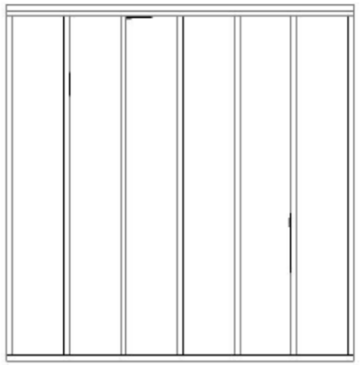
installation shall be *at least* this good to be labeled as "Grade III":





No more than 2% of surface area of insulation missing is acceptable for "Grade II"

"Grade I":

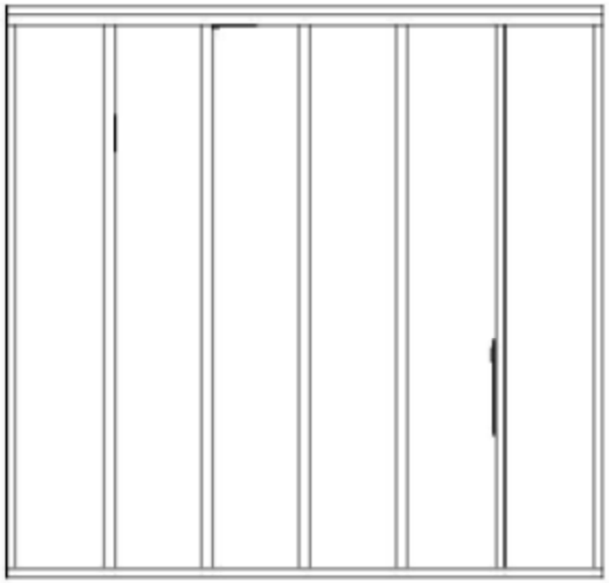


Occasional very small gaps are acceptable for "Grade I".

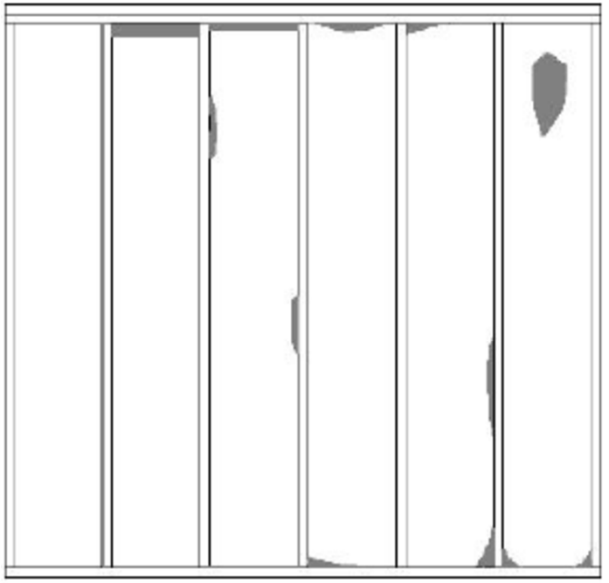
Grade I

RESNET Appendix A-11 - A-13

- occasional very small **gaps/voids**
- less than 2% **compression/incomplete fill**
  (which may not be more than 30% compressed)



Gaps

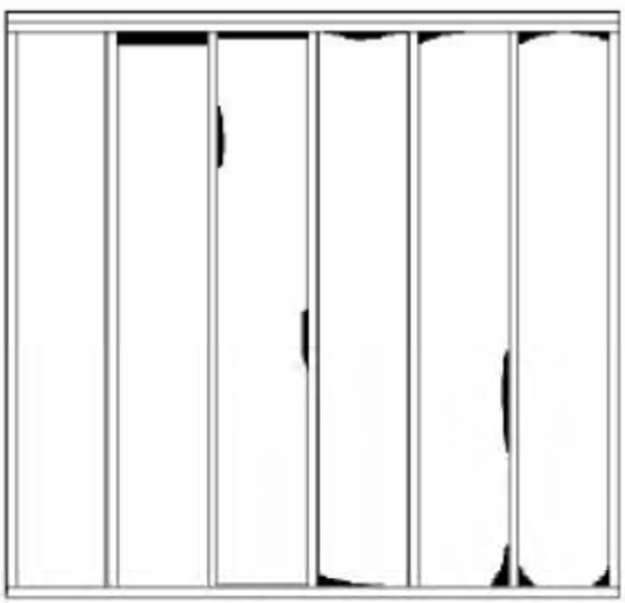


Compression

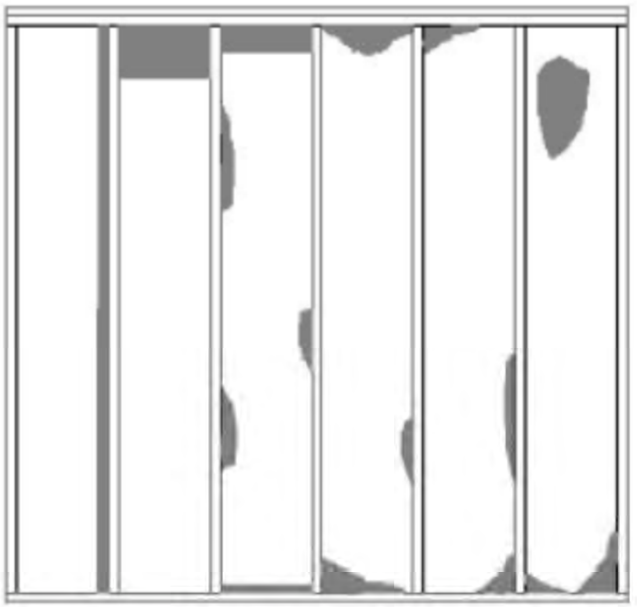
Grade II

RESNET Appendix A-13 - A-15

- <2% **gaps/voids**
- <10% **compression/incomplete fill**
  (which may not be more than 30% compressed)



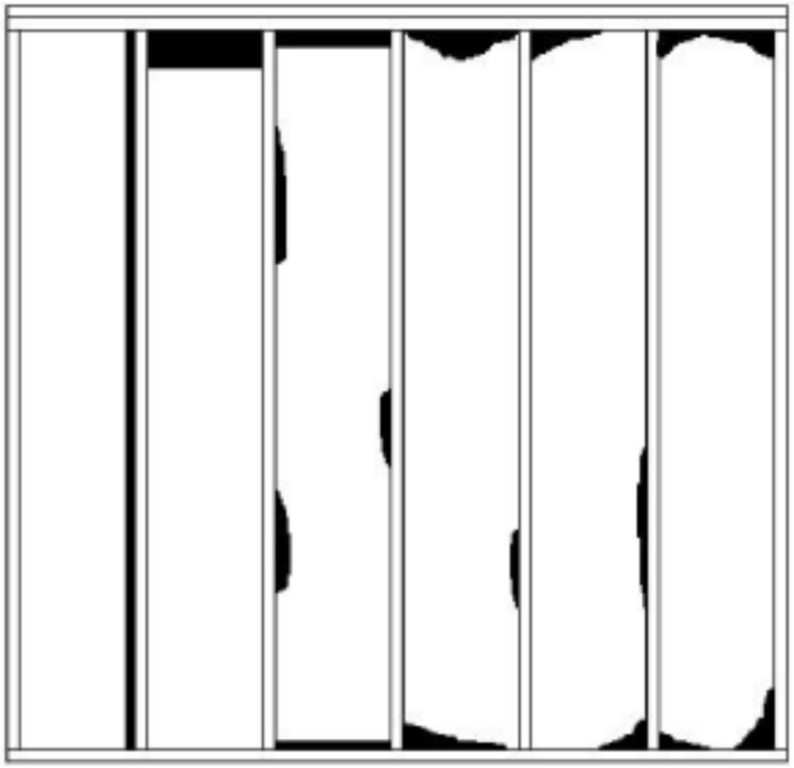
Gaps



Compression

Grade III

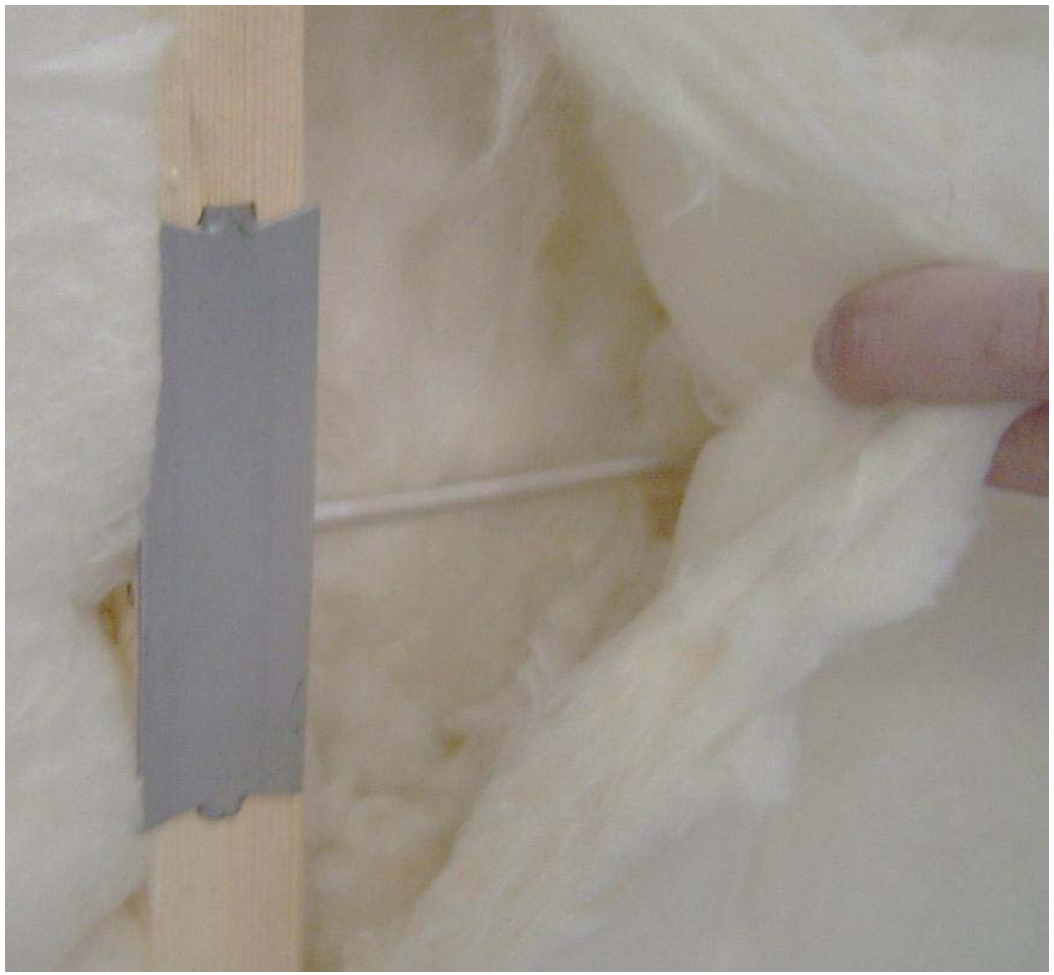
RESNET Appendix A-15 - A-16



Gaps

- > 2% and ≤ 5% **gaps/voids**
- (greater than 5% = downgraded R-value)
- 10% or worse **compression/incomplete fill**

What Grade?



What Grade?

What Grade?