Build a Better House at Lower Cost by Controlling Air Infiltration

Makers of Enviro-Dri® Weather-Resistant Barrier

TREMCO Barrier Solutions

AIA Course Detail
Learning Objectives

- **The course objectives are to understand:**
  - The value of the performance path to meet energy codes
  - The value of added insulation diminishes
  - The power of reducing air infiltration in meeting code
  - Improved construction methods to control air infiltration

Tremco Barrier Solutions
Speaker & Background

- Dr. Jim Wells PhD. - Technical Director, TBS
  - Graduated & Taught Engineering at Purdue
    Aeronautics, Astronautics & Engineering Sciences
  - Over 30 years R&D in Construction Products
    - Owens Corning: Insulation & Roofing Systems -15 years
    - Koch Materials: Highway Systems – 5 years
    - Residential Barrier Systems – 10+ years

Tremco Barrier Solutions
RPM Company Background

Maximum Return on Construction Cost

Waste and Value

- Sustainability: the elimination of waste
  - Balance People, Planet, and Prosperity
- Eliminating waste **adds value**
- Using more resources than needed to meet the 2009, 2012 or any code is **waste**
- Using resources efficiently to meet your energy goals **adds value** (eliminating waste)
- Resources saved can be used elsewhere to **add value**
- Sustainable construction: resources adding max value

Maximizing the Return On Your Construction Cost

Our Focus

- How to meet your energy goals cost effectively:
  - 2009, 2012 IECC Code, beyond-code programs
- Air infiltration, vapor diffusion & “tightness”
  - Energy and moisture considerations
- Air infiltration control strategies
- *Your three friends*

Maximum Return on Construction Cost
Meeting Energy Codes

- Two methods to show code compliance
  - Prescriptive
    Use the list; **the list determines your cost**
  - Performance
    Use performance; **you choose the best way**
    Performance method required by Energy Star and most utility incentive programs

Maximum Return on Construction Cost

IECC Prescriptive Code – CZ 5

Prescriptive Elements	2004	2006	2009	2012
Window-U	0.4	0.35	0.35	0.32
Ceiling R	38	38	38	49
Frame Wall R	15	19, 13+5	20, 13+5	20, 13+5
Bsmt Wall R	10/13	10/13	10/13	15/19
Air Infiltration (ACH_{50})	NA (7.0)	NA (7.0)	NA (7.0)	3.0

Maximum Return on Construction Cost

IECC Prescriptive Code – CZ 4

Prescriptive Elements Z4	2003*	2006	2009	2012
Window-U	0.48	0.40	0.35	0.35
Glazing SHGC	NR	NR	NR	0.40
Ceiling R	38	38	38	49
Frame Wall R	13	13	13	20, 13+5
Bsmt Wall R	8	10/13	10/13	10/13
Air Infiltration (ACH50)	NA (7.0)	NA (7.0)	NA (7.0)	3.0

* approximate values for new simplified climate zones

Maximum Return on Construction Cost

Diminishing Value of Insulation

- The first R is the best R
- The value of adding insulation diminishes
- To reduce energy loss by 50%, double the R

Example: Energy lost through a ceiling area

R-value Added	Total R-value	BTU Used	BTU Saved
0	R-1	100	0
1	R-2	50	50
2	R-4	25	25
4	R-8	12	12
8	R-16	6	6
16	R-32	3	3

- **The first R saved 50, the last 16-Rs added saved 3**

Maximum Return on Construction Cost
Diminishing Value of Insulation

- Example: 2-Story with 1,350 Ft^2 ceiling area

Ceiling R-value	Annual Heating & Cooling		
	MM-BTU	$ Saved	% Saved
Unins.	57.3	0	0
5	30.5	$184	49%
10	17.8	$88	23%
20	10	$54	14%
38	5.7	$30	8%
49	4.6	$8	2%
100	2.3	$15	4%
		$379	**100%**

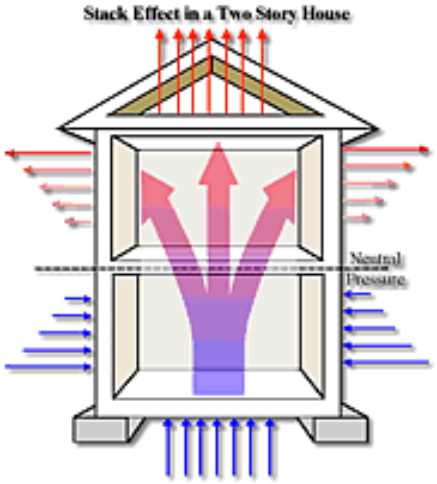
R-38 to R-49: Even simple payback calculation exceeds 50 years, a very poor value

Maximum Return on Construction Cost

Stop Air Infiltration to Save Energy

Conditions for air infiltration

- Pressure difference (high to low)
- Holes, gaps, and cracks allowing air flow



Driving forces

- Temperature difference (stack effect)
- Wind
- Mechanical systems imbalance

ACH_{50} (test result) and ACHn (reality)

- ACHn (per day) is approx 1.3 times ACH50 (per hour)
- ACH_{50} (1 – 7) is approximately ACHn=(3 – 9)

Maximum Return on Construction Cost
Lowering ACH vs. Adding R-value

- Example: 2-Story with 1,350 Ft^2 ceiling area

Air Infiltration ACH_{50}	Annual Heating & Cooling		
	MM-BTU	$ Saved	% Saved
7	89.0	0	0
6	82.6	$41	18%
5	76.2	$41	18%
4	70.0	$40	17%
3	63.8	$40	17%
2	57.7	$38	17%
1	52.9	$29	13%
		$229	**100%**

Maximum Return on Construction Cost Meeting Energy Codes

- The annual energy cost shows the striking difference in the value created by lowering ACH vs. more ceiling insulation
- Other ways to benefit from the value created
  - Occupant comfort (ACH_{50} vs ACHn)
  - Right-sizing HVAC equipment
  - Lower initial construction costs

Maximum Return on Construction Cost
Meeting Energy Codes

- We can use this higher-value construction alternative to meet current and future energy codes more economically.
- Higher value now and later
  - 2009 IECC now, 2012 IECC later
  - And beyond code programs and incentives
- Example: 2,700 ft^2 two story with basement

Maximum Return on Construction Cost

Whole House Impact – Zone 5

New York 2009 IECC-based Zone 5 Code Minimizing Additional Construction Costs

Code	Frame Walls	Ceiling	Bsmt Walls	Windows	ACH_{50}	Added Cost Avoided
09 IECC	R-20, R-13+5c	R-38	R-10 Cont	U-0.35	7.0	0.0
Performance	R-15	R-38	R-5 Cont	U-0.35	4.8 - 5.1*	$ 1,515.00

*** depending on insulation installation quality**

Meet 2009-based Code more economically today.

Maximum Return on Construction Cost

Whole House Impact – Zone 5

New York 2012 IECC-based Zone 5 Code
Minimizing Additional Construction Costs

Code	Frame Walls	Ceiling	Bsmt Walls	Windows	ACH_{50}	Added Cost Avoided
12 IECC	R-20, R-13+5c	R-49	R-15	U-0.32	3.0	0.0
Performance	R-15	R-38	R-10 Cont	U-0.35	3.0	$ 2,069.00+

And be prepared to meet 2012-based code more economically.

Maximum Return on Construction Cost

Whole House Impact – Zone 4

New York 2009 IECC-based Zone 4 Code
Minimizing Additional Construction Costs

Code	Frame Walls	Ceiling	Bsmt Walls	Windows	ACH_{50}	Construction Cost Avoided
09 IECC	R-13	R-38	R-10 Cont	U-0.35	7.0	0.0
Performance	R-13	R-38	None	U-0.35	3.3	$ 650.00

Meet 2009-based Code more economically today.

Maximum Return on Construction Cost

Whole House Impact – Zone 4

New York 2012 IECC-based Zone 4 Code
Minimizing Additional Construction Costs

Code	Frame Walls	Ceiling	Bsmt Walls	Windows	ACH_{50}	Construction Cost Avoided
12 IECC	R-20, R-13+5	R-49	R-10 Cont	U-0.35	3.0	0.0
Performance	R-15	R-38 Bln	R-5 Cont	U-0.35	2.5	$ 2,069.00

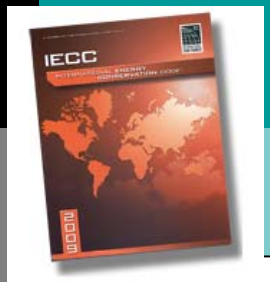
And be prepared to meet 2012-based Code more economically.

Maximum Return on Construction Cost

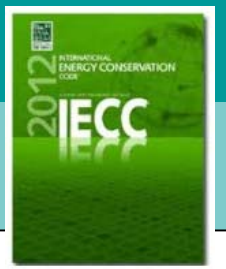
Meeting 2012 code and More

- Use the insulation/air change trade-off that best suits your building practice
- Ceiling – wall - crawl insulations, window U-value
- Right size HVAC equipment & maintain comfort
- Stay with 2x4 walls if desired
- Energy raters/designers have the tools and help you meet your energy goals most advantageously

- the Performance Path is your friend

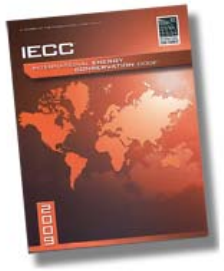


Performance Path Process



Performance Path – HERS Rater Building Modeling

- Provide a HERS Rater with your drawings, equipment selections and other details
- Your Rater computer models the home and provides you with IECC Compliance Report and Certificate to Post, and **may** provide alternatives and improvement ideas
- Your Rater **may** provide building science consulting on structural options, best practices and warranty concerns
- Your Rater **may** help you qualify for available tax credits and various High Performance Home Certifications
- Your Rater inspects insulation before drywall and runs blower door and duct blasting tests after trim is installed

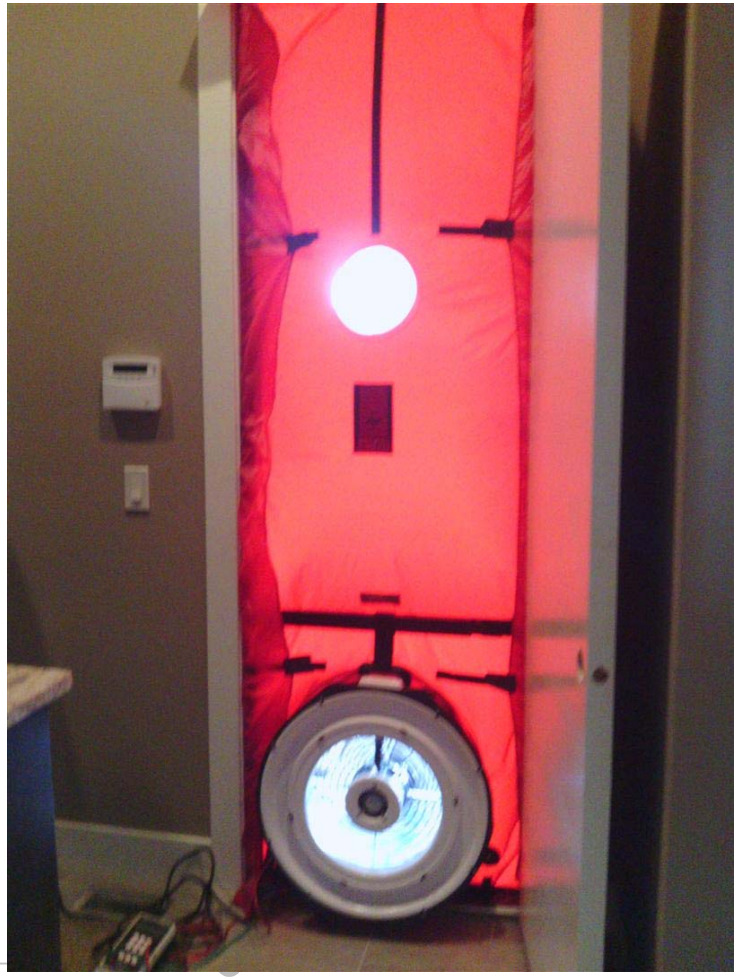


Performance Path
2009 Mandatory Items

IECC 2009 mandatory Requirements for Both Paths

- Maximum Fenestration U-values
- Programmable Thermostat
- Duct Sealing and testing if outside conditioned space
  - Building Framing Cavities can NOT be used as ***SUPPLY*** Ducts.
- Mechanical System Piping must be R-3
- Circulating Hot Water Systems must have R-2
- Mechanical Ventilation
- Equipment Sizing in Accordance with IRC Section M1401.3

Performance Path
Testing ACH_{50}



Performance Path
Testing Duct Leakage

Performance Path Compliance Certificates

Performance Path – Compliance documentation

- Your Rater helps you meet your energy goal and provides the compliance documentation
  - Meet code, Energy Star, tax credits, utility incentives, etc.

Maximum Return on Construction Cost Performance Path: Process & FAQ

- The performance path is your friend, but is it complicated?
- NO, and it can make money for you
- Review Process (prescriptive vs. performance)
- Review FAQ

Maximum Return on Construction Cost
Summary and a Question

- Summary
  - Added insulation value diminishes
  - Controlling air changes adds consistent value
  - Controlling air changes can lower construction cost
  - Controlling air changes helps maximize any utility incentives
  - The performance path can help you meet you energy goals at **lower construction** cost vs. Res check
- But what about building too tight?

Building the Right Tightness
Science & History

- **Air changes** and **permeability** are not the same.
  - Air (with water vapor) passes through holes - ACH
    - Moisture laden air can condense and add water to walls
    - You can't assume that the uncontrolled air will actually dry out an affected area (inconsistent)
    - Uncontrolled air movement is a problem not a solution
  - Water vapor passes through solids without holes - perms
    - Perms dry out all wall cavities at predictable rates
    - Perms of OSB plus anything is less than OSB alone: 3-4 at high RH
    - Water vapor diffusion can NOT cause a problem, may help solve one

Maximum Return on Construction Cost

Allow Vapor Diffusion for Drying

- Conditions for vapor diffusion
  - Water vapor pressure difference
    (vapor moves from high to low vapor pressure)
  - Vapor permeable transmission medium
    - Vapor can flow through permeable solid materials
      Wood, polymers, organic material – Yes
      Glass, metal, non-porous inorganic material – No
- Factors that Determine Amount and Rate
  - Size of the vapor pressure difference
    - determined by temperature and relative humidity
  - Permeability of the medium

Building the Right Tightness
Permeability and Air Leakage

- System perms of OSB Plus WRB
  - In humid environment, OSB alone = 4-6 perms,
  - OSB plus anything is lower perm than OSB alone
    - Using OSB perms = 4.0
    - OSB plus Tyvek(58) is ~ 3.7 perms, plus low-perm wrap(6) is ~ 2.4 perms
    - OSB plus Enviro-Dri (16) is ~ 3.2 perms
    - Difference is small and of no consequence
    - Amount of vapor transmitted (1/4 to 1/2 cup during heating season) is far less than the framing absorbs (5 – 6 cups per 2x4 wall cavity)
  - Permeability is ***not*** the issue
  - Uncontrolled air flow is the issue

Water or Water Vapor Transmission
Enviro-Dri

- ***Uncontrolled air movement can introduce over 100 times the moisture into walls than by diffusion!***
- Moisture Control Priorities
  - Stop liquid water leaks
  - Stop uncontrolled air movement
  - Maintain permeability for drying
  - Use wood frame construction –(*hygric buffering*)
- Is it Too tight? In what sense?
  - Uncontrolled air movement: the goal is zero
  - Vapor diffusion: prudent for more fail safe walls

Building the Right Tightness

Science & History

- **Nationally Recognized Building Science Consultants**
  - **Joe Lstiburek, President Building Science Corporation**
    with extensive building science credentials and practical experience
    "The solution to moisture issues in walls is to decrease wetting potential, not trying to increase drying potential" "Build it tight and ventilate right."
  - **Steve Easley, Principle S.C. Easley & Associates**
    with extensive building science credentials and practical experience
    "my field experience has taught me that leaky building shells cause problems and increase chances for mold growth." "Build tight, ventilate right"

- tight, permeable construction is your friend

Building Better Homes
Controlling Air Infiltration

- Focus – controlling air flow
  - Ceilings, attic details, penetrations
  - Windows/doors
  - **Walls**
- Methods – how to do it
  - Interior
  - Exterior

Building Better Homes
Products and Practices-Interior

- AIP – standard practice, not very effective

Building Better Homes
Products and Practices-Interior

- Owens Corning Energy Complete air sealing

Effective but expensive alternative to reduce air infiltration

Building Better Homes
Products and Practices-Interior

- Spray foam insulation and air barrier

Effective but expensive alternative to reduce air infiltration

Building Better Homes
Products and Practices-Interior

- “Dense pack cellulose”

Building Better Homes
Products and Practices-Exterior

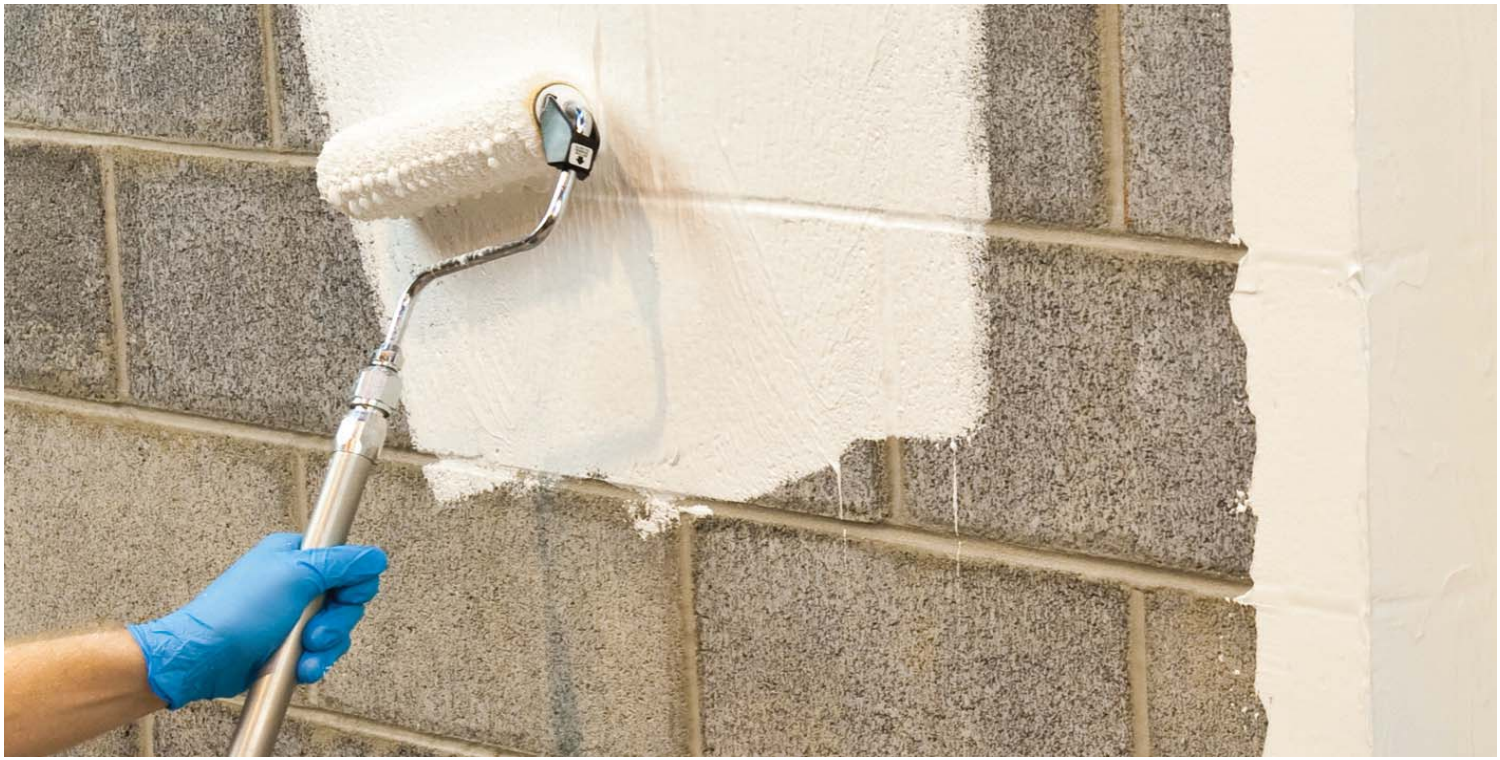
- Housewrap sheet-applied

Building Better Homes
Products and Practices-Exterior

- Exterior foam – lacks permeability
- Air barrier when seams taped

Building Better Homes
Products and Practices-Exterior

- DuPont fluid applied - Moisture and air control



Building Better Homes
Products and Practices-Exterior

- Sto fluid applied - Moisture and air control

Building Better Homes
Products and Practices-Exterior

- TBS fluid applied - Moisture and air control

- a liquid-applied air/water barrier is your friend

Building the Right Tightness
Robust (Forgiving) Walls

- **Stop Liquid Water Leaks**
  - Liquid-applied WRB systems perform significantly better than wraps
- **Reduce Wetting Potential –via uncontrolled air flow**
  - Liquid-applied WRBs significantly reduce uncontrolled air flow
  - Can replace other AIP wall elements
  - Enviro-Dri 8’ x 8’ wall section tests indicate 90% reduction potential
- **Maintain Good Drying Potential – via vapor diffusion**
  - Interior/Exterior vapor pressure difference & system perms
  - Enviro-Dri/OSB has a similar diffusion rate as wrap & OSB combination
- **Enviro-Dri and wood framing form a robust system**
  - Can buffer significantly more water than system allows to enter
  - Can use economical fiberglass insulation

Liquid-Applied WRB Systems

Wrap-up

- **Quiz: To meet Energy Codes and get the most value for your construction $, what are your three friends?**

Liquid-Applied WRB Systems

Wrap-up

- **Quiz: To meet Energy Codes and get the most value for your construction $, what are your three friends?**

  - the Performance Path is your friend

Liquid-Applied WRB Systems

Wrap-up

- **Quiz: To meet Energy Codes and get the most value for your construction $, what are your three friends?**

  - the Performance Path is your friend

  - tight, permeable construction is your friend

Liquid-Applied WRB Systems

Wrap-up

- **Quiz: To meet Energy Codes and get the most value for your construction $, what are your three friends?**

  - the Performance Path is your friend

  - tight, permeable construction is your friend

  - a liquid-applied air/water barrier is your friend

AIA Course Detail
Conclusions/Questions

- ***Questions and Comments ?***

End of AIA Course Content

Building Better Homes

Envelope Moisture and Air Control

Liquid-Applied

Weather-Resistant Barrier Systems

- Extends protection from sill to roof line
- Code-approved water-resistive barrier
- Superior alternative to house wraps and taped systems
- Single system provides moisture and air control
- Helps you to reliably obtain maximum value from your construction dollars in meeting code, or qualifying for above-code rebates and incentives

Booth # 908

Build a Better House at Lower Cost by Controlling Air Infiltration

Orlando, FL Feb 28, 2013

TREMCO Barrier Solutions