Doing Better for Less

R-30 Walls and Beyond

High Performance, Less Cost

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www.maineindoorair.org

Building Science Basics

Bulk Water Management

Heat Flow Management

Vapor Management

Air Flow Management

IECC 2015

Per Table R402.1.2

In Climate Zones 6, 7 and 8…
Wood Frame Wall R-Value = 20+5 or 13+10
The first value is cavity insulation, the second value is continuous insulation

This requirement disallows the use of "cavity only insulation"

Note: Air Tightness is Absolutely Critical and Assumed Throughout

IECC 2009

Table 402.1.1
Insulation and Fenestration Requirements by Component[a]

CLIMATE ZONE	FENESTRATION U-FACTOR[b]	SKYLIGHT[b] U-FACTOR	GLAZED FENESTRATION[b,e] SHGC	CEILING R-VALUE	WOOD FRAME WALL R-VALUE	MASS WALL R-VALUE[i]	FLOOR R-VALUE	BASEMENT[c] WALL R-VALUE	SLAB[d] R-VALUE & DEPTH	CRAWL SPACE[c] WALL R-VALUE
1	1.20	0.75	0.30	30	13	3 / 4	13	0	0	0
2	0.65[j]	0.75	0.30	30	13	4 / 6	13	0	0	0
3	0.50[j]	0.65	0.30	30	13	5 / 8	19	5 / 13[f]	0	5 / 13
4 except Marine	0.35	0.60	NR	38	13	5 / 10	19	10 / 13	10, 2ft	10 / 13
5 and Marine 4	0.35	0.60	NR	38	20 or 13+5[h]	13 / 17	30[g]	10 / 13	10, 2 ft	10 / 13
6	0.35	0.60	NR	49	20 or 13+5[h]	15 / 19	30[g]	15 / 19	10, 4 ft	10 / 13
7 and 8	0.35	0.60	NR	49	21	19 / 21	38[g]	15 / 19	10, 4 ft	10 / 13

IECC 2015

TABLE R402.1.2
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	FENESTRATION U-FACTOR[b]	SKYLIGHT[b] U-FACTOR	GLAZED FENESTRATION SHGC[b,e]	CEILING R-VALUE	WOOD FRAME WALL R-VALUE	MASS WALL R-VALUE[i, j]	FLOOR R-VALUE	BASEMENT[c] WALL R-VALUE	SLAB[d] R-VALUE & DEPTH	CRAWL SPACE[c] WALL R-VALUE
1	NR	0.75	0.25	30	13	3/4	13	0	0	0
2	0.40	0.65	0.25	38	13	4/6	13	0	0	0
3	0.35	0.55	0.25	38	20 or 13+5[h]	8/13	19	5/13[f]	0	5/13
4 except Marine	0.35	0.55	0.40	49	20 or 13+5[h]	8/13	19	10/13	10, 2 ft	10/13
5 and Marine 4	0.32	0.55	NR	49	20 or 13+5[h]	13/17	30[g]	15/19	10, 2 ft	15/19
6	0.32	0.55	NR	49	20+5 or 13+10[h]	15/20	30[g]	15/19	10, 4 ft	15/19
7 and 8	0.32	0.55	NR	49	20+5 or 13+10[h]	19/21	38[g]	15/19	10, 4 ft	15/19

2015 Vermont Residential Energy Standards

TABLE R402.1.2
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

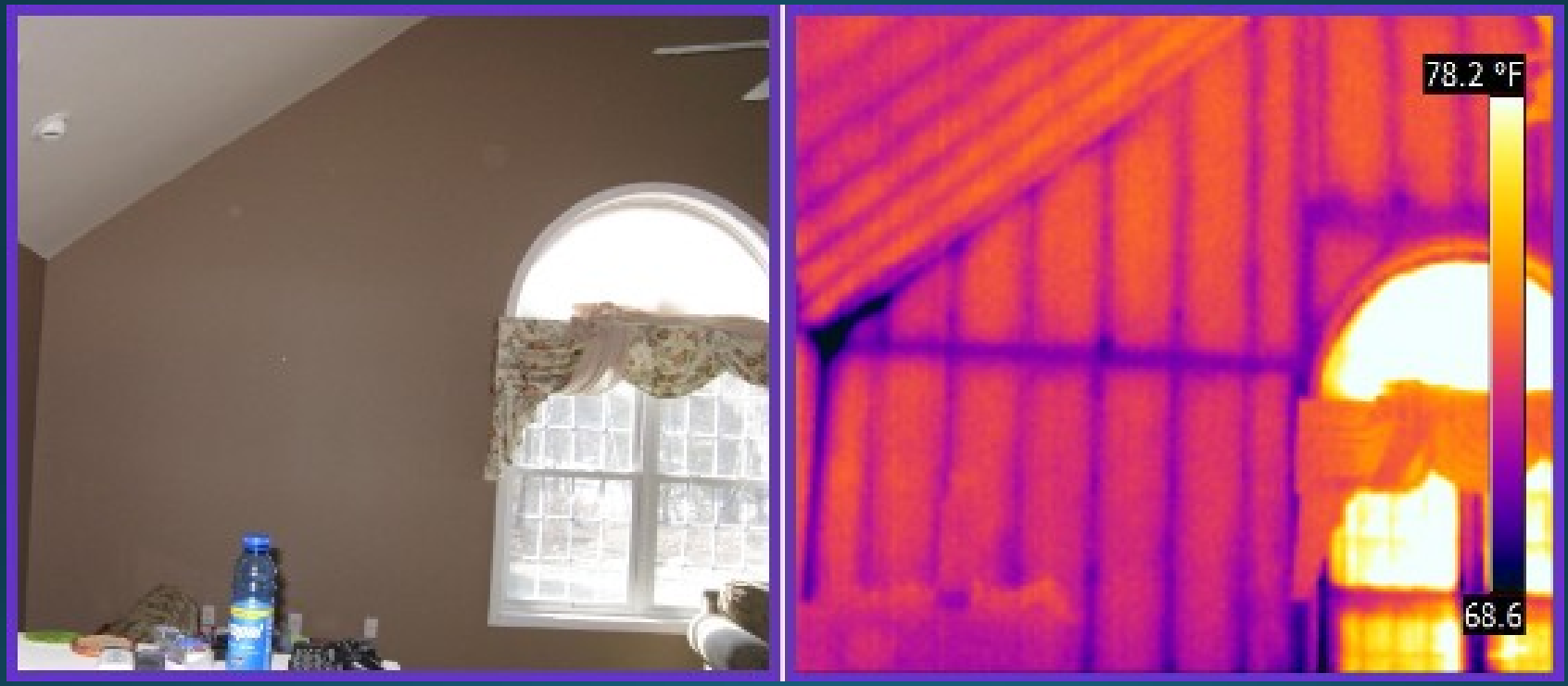
PACKAGE #[i]	FENESTRATION *U*-FACTOR[b]	SKYLIGHT[b] *U*-FACTOR	CEILING[h] *R*-VALUE	WOOD FRAME WALL[f] *R*-VALUE	MASS WALL[g] *R*-VALUE	FLOOR *R*-VALUE	BASEMENT[c] & CRAWL SPACE WALL *R*-VALUE	SLAB[d] *R*-VALUE & DEPTH	HEATED SLAB[d] *R*-VALUE
1	0.32	0.55	49	13 + 10	15/20	30[e]	15 continuous or 20 cavity	15, 4 ft	15, edge and under
2	0.28	0.55	49	25	15/20	30[e]	15 continuous or 20 cavity	15, 4 ft	15, edge and under

For SI: 1 foot = 304.8 mm.

The ineffectiveness of “Cavity Only Insulation”

Poorly fitted fiberglass batts

Uninsulated basement



Heat Flow Management

Reduce conductive losses by placing
resistive material
in the path of heat flow

Disrupt thermal contact

“Thermal Break”

Continuous Insulation Methods meeting IECC 2015 include

Insulated exterior sheathing

Insulated interior sheathing

Zero Stud Construction (SIPS, ICF)

Double Stud Construction

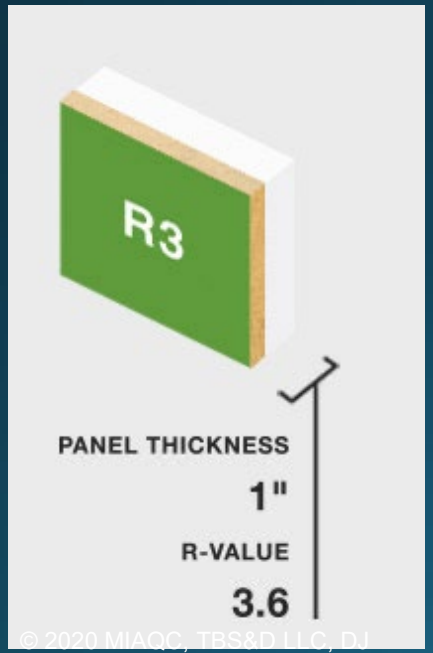
2” insulated sheathing on 2x6 studs

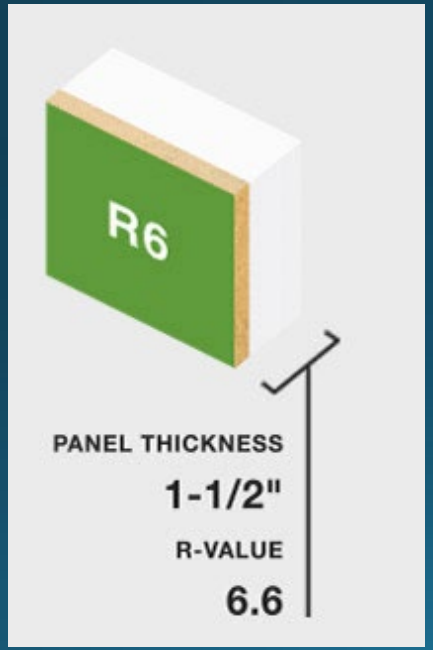
Climate zone	Minimum R-value for exterior foam installed on an existing 2x4 wall	Minimum R-value for exterior foam installed on an existing 2x6 wall
Marine 4	2.5	3.75
5	5	7.5
6	7.5	11.25
7 and 8	10	15

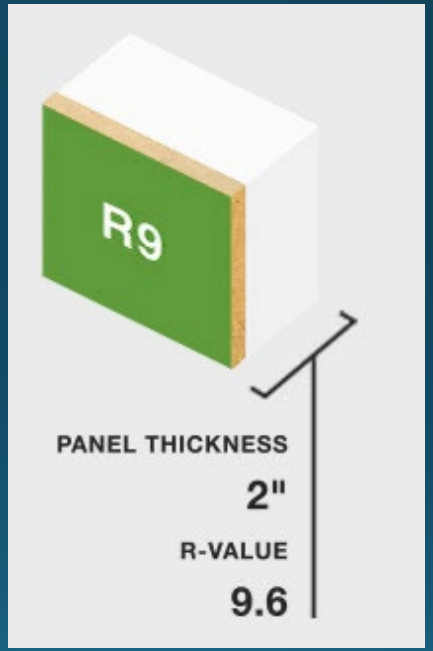
Minimum True R-values
for
exterior foam applications
IRC R702.7.1

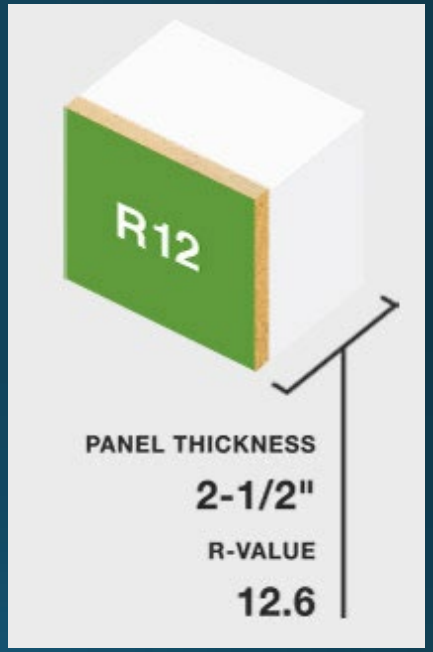
w/Class III VDR

Zip System R-Sheathing







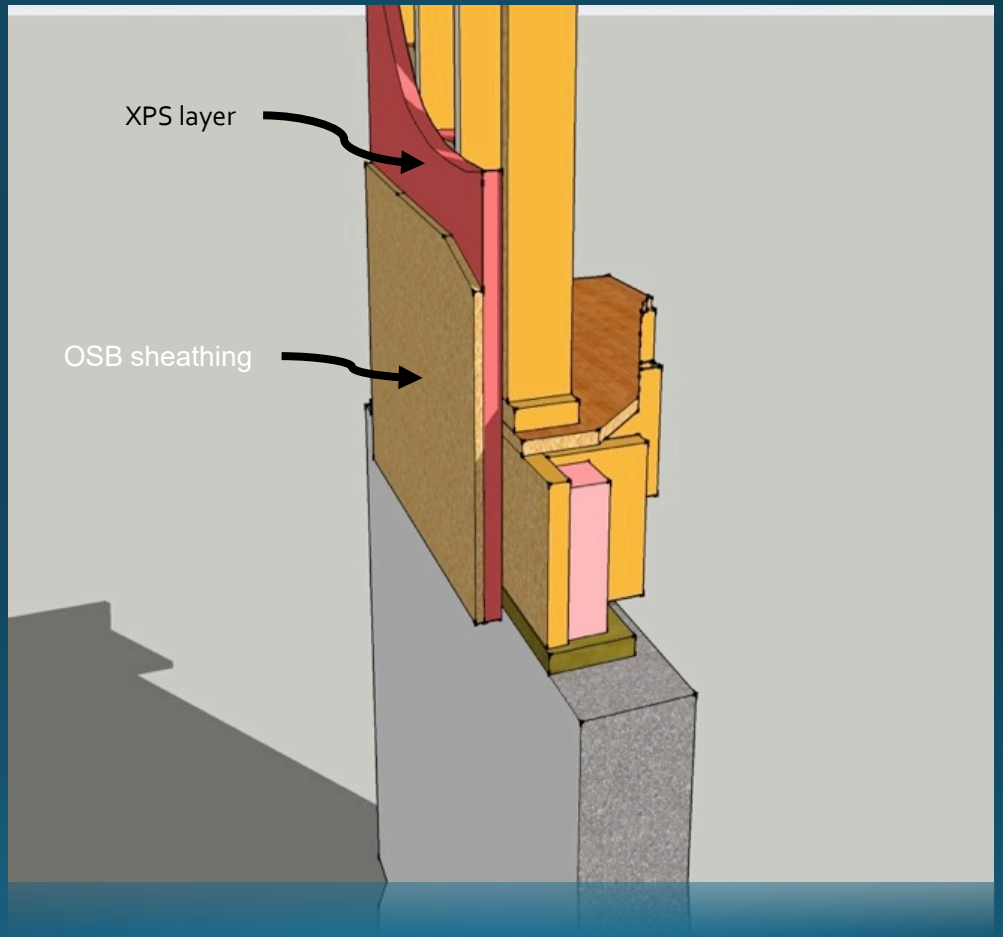


Taped XPS over structural sheathing

PT strapping over XPS

Warm framing

Cold sheathing



PERSIST SYSTEM… Pressure Equalized Rain Screen Insulated Structure

Warm Framing and Sheathing

Courtesy Unity Homes

Modified Wall

No Thermal bridging

Warm framing

Insulated vinyl siding

R-value of 2.6 +/-

Not continuous

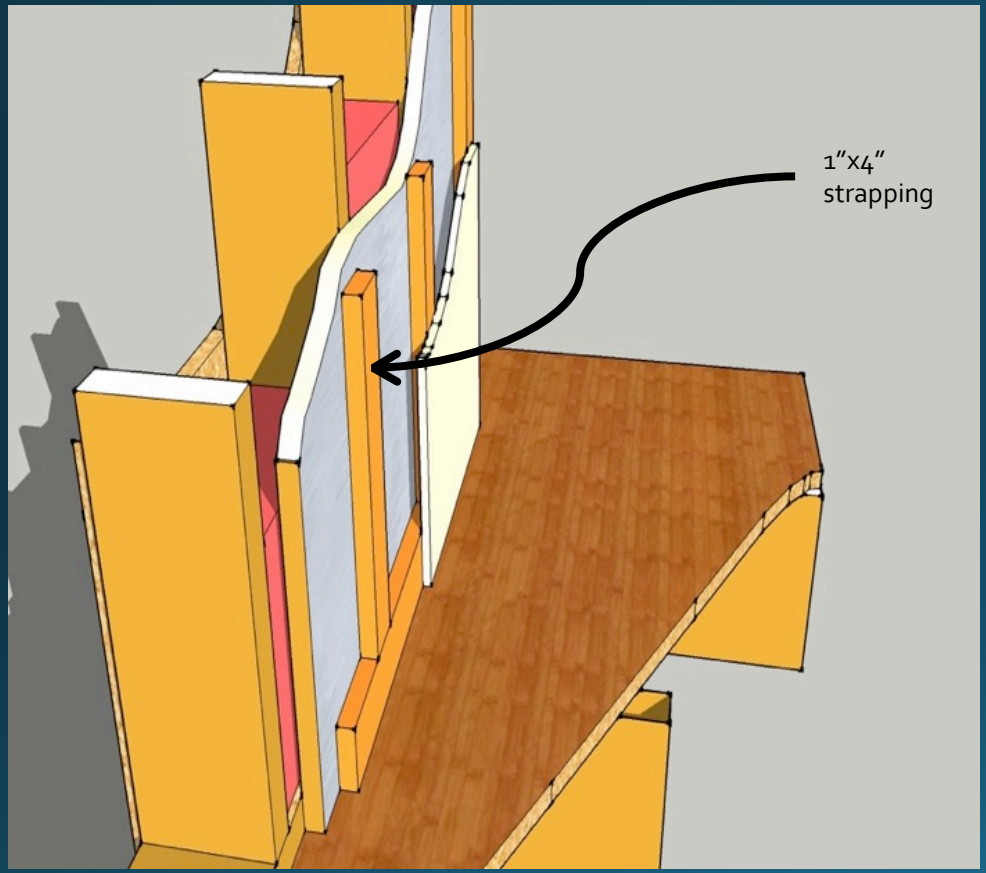
May impair bulk water management

Courtesy Fine Homebuilding

“Flash and Batt” system
does not meet 2015 IECC

It is still a ”cavity only” insulation method

Dew point issues may arise
as well



1” foil faced isocyanurate

Improved radiant heat management

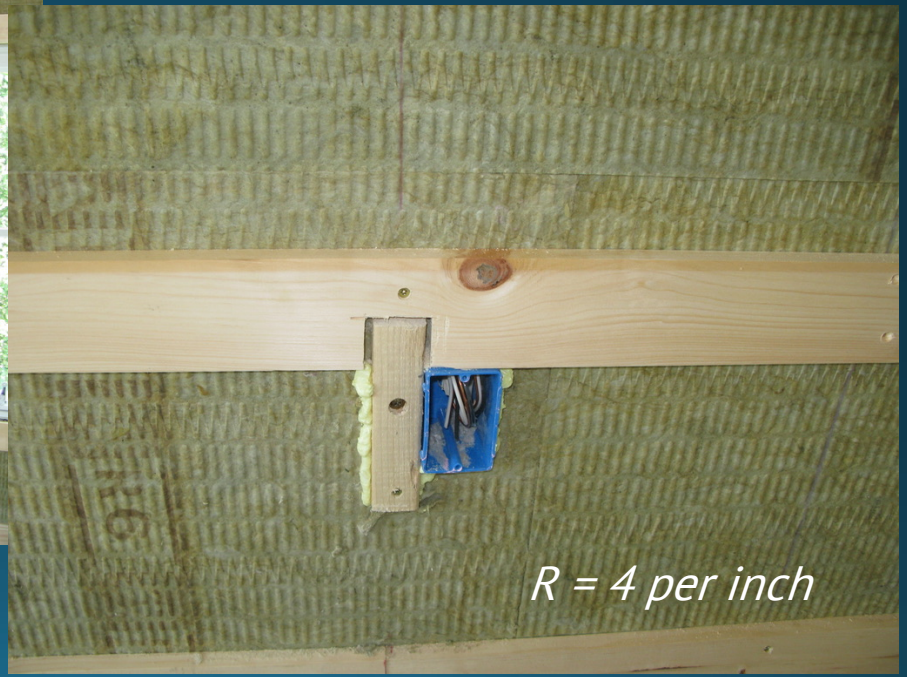
Outlet difficulties

Cold sheathing

Foil faced isocyanurate

1x4 horizontal strapping

Roxul Comfortboard™ 80…



…over dense packed cellulose

No Stud Versions

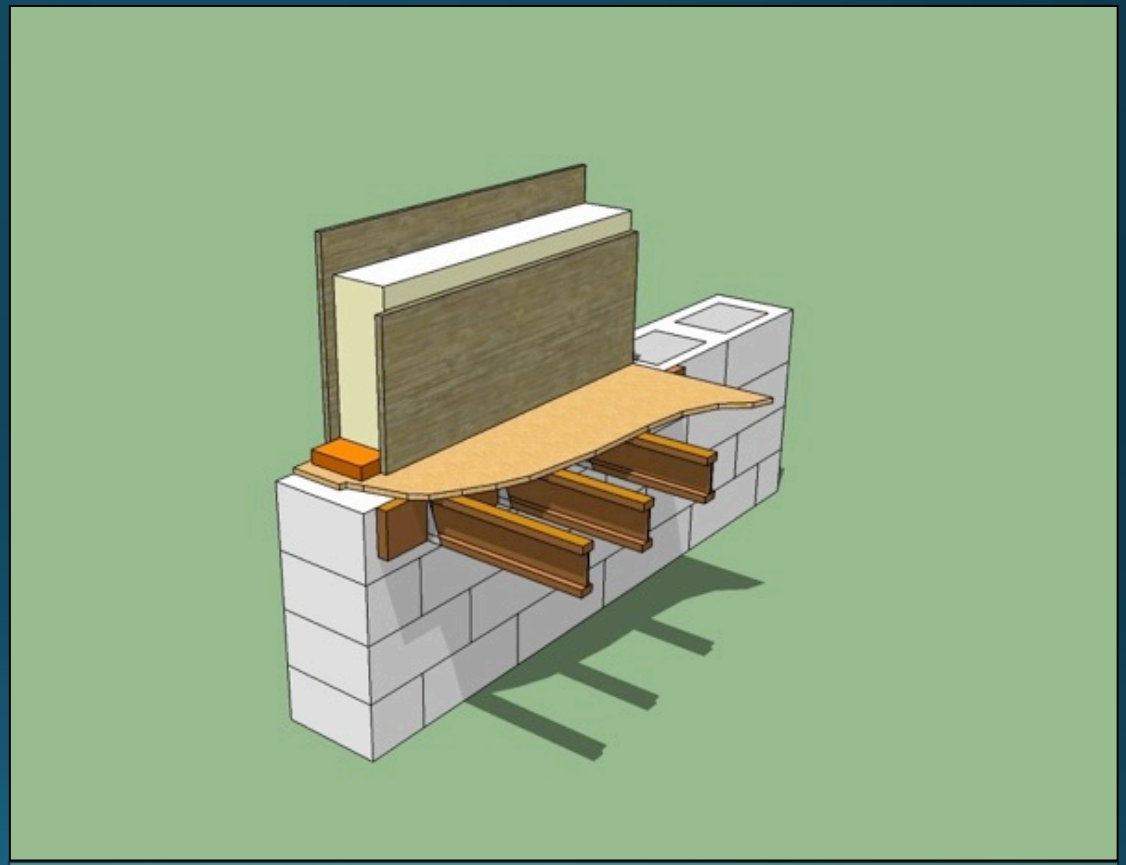
SIP over ICF

High insulation values

Requires careful construction

Repair problems

Insect infestation?



Poor bulk water management

Outer OSB panel destroyed

Structural integrity compromised

”Cavity only” or “Continuous”?

Double stud arrangement

Inner wall bears second floor load

Larsen™ Truss for major wall retrofit

Tstuds

Courtesy Marc Sloot and FHB

“Wrap and Strap” Double Wall System

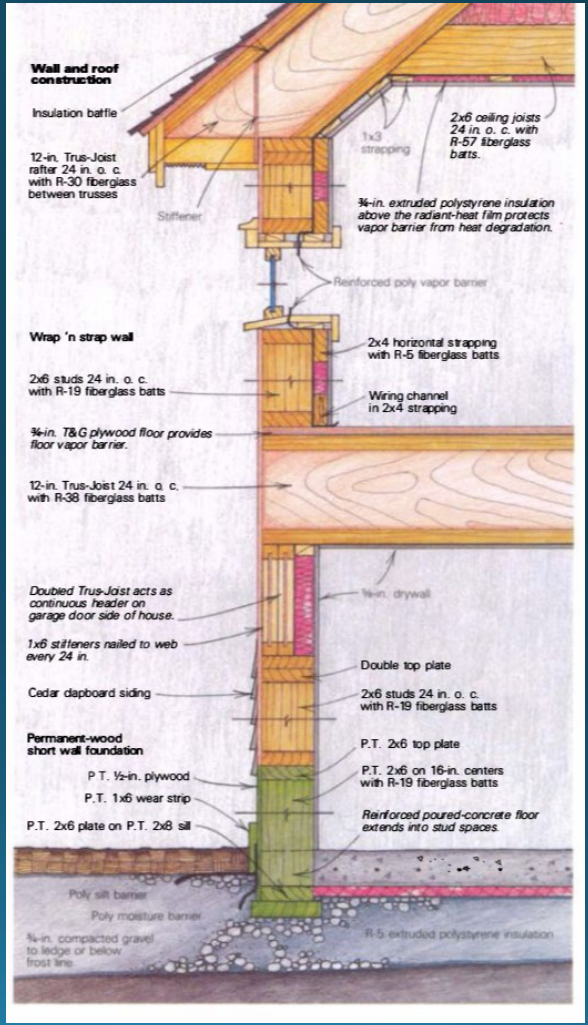
Insulation and membrane omitted for clarity

Fine Homebuilding

Issue # 34

August/September 1986

“A Superinsulated Saltbox”



2X6 stud wall

4 mil TuTuff™ V/AB

4x2 purlins

Note V/AB sheets and Tremco™ acoustical sealant

Site sawn 2x4 pine purlins

GRK 6” lags as fasteners

Note non-aligned top

Note XPS base

Heat pump tubing

Detail at window

Preventing plate to plate alignment

Ready for the trades

Oops! The framer forgot…
partition pickups are unnecessary

All the trades work inside the 2x6 outer wall…

…after the outer wall is insulated!

Even the heat pump system is operational

Much easier cold weather construction

Ignoring windows and doors…

What percentage of total wall area comprises the vertical/horizontal intersections?

Building perimeter = 172LF
Total number of vertical studs = 100
Number of horizontal runs = 5
Total intersections = 500

Individual intersection area = .016SF
Total intersection area = 8.0SF
Total wall area = 172 x 8 = 1376SF
8.0/1376 x 100 = 0.58%

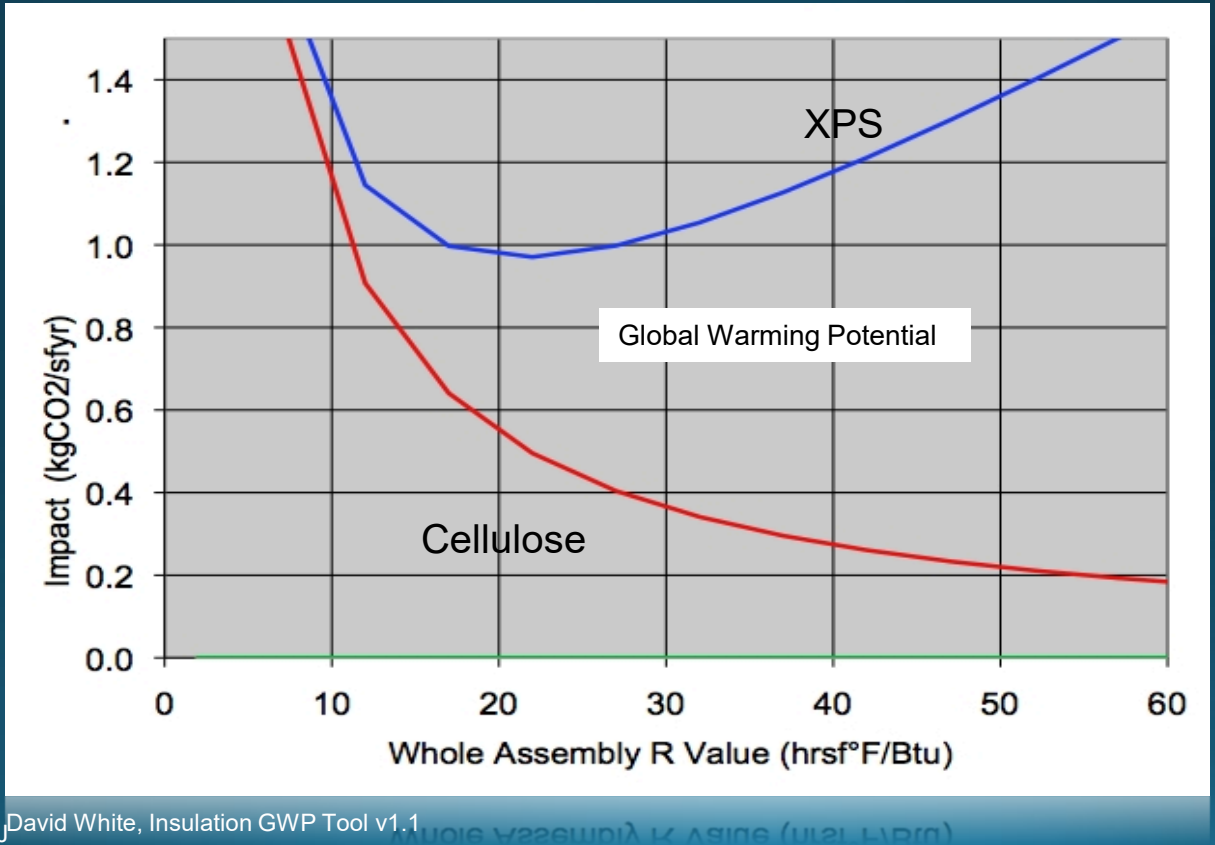
About one half of one percent of the total wall area

Drywall installed vertically

Standard wall framing

Non typical cathedral ceiling

Consider Climate Impact of Insulation Materials



David White, Insulation GWP Tool v1.1

Heat Flow Management

Radiation

Dealing with MRT

The importance of Mean Radiant Temperature (MRT)

Operative temperature is what humans experience thermally in space

$$T_o = (T_{mr} + T_{db})/2$$

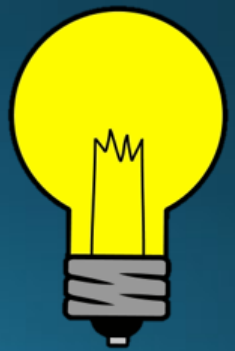
Relationship between warm human body and cold wall

Ignoring the constants in the Stefan-Boltzmann formula,

For every ΔT°, the human body radiates 9 additional watts of heat energy

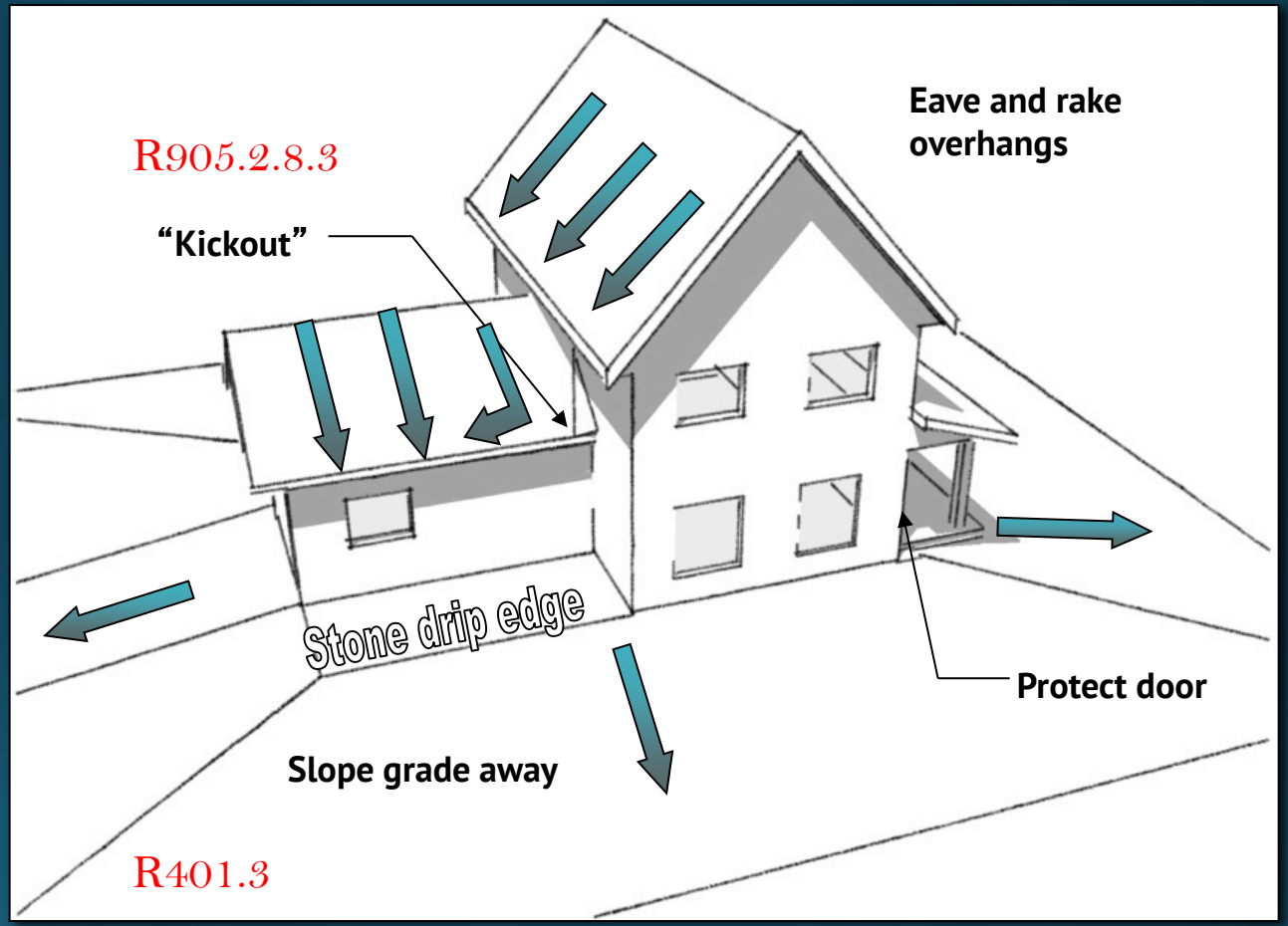
With a ΔT° of 10°, radiated energy is equal to 90 watts

A ΔT° of 30° raises that radiated energy to 270 watts



Bulk Water Management

Drain rain



Home Slicker™

Continuous airflow behind the cladding

Expensive ?

Consider the long run

Interior Moisture Management

Reduce *vapor diffusion* into assembly

Prevent *air leakage* into assembly

Plan on some moisture penetration into assembly
Allow for drying pathway

“Vapor Open” Wall Systems

Allow drying either to the outside, the inside, or both

Vapor Barriers or Vapor Diffusion Retarders complicate the picture

Plan for moisture sensitive material in the wall to be above 45° F

Wall Assembly Assessment

Permeability of each component
Least vapor permeable component
Extent and direction of vapor drive
Moisture storage and potential drying

Class I Vapor Retarder (vapor barrier): less than or equal to 0.1 perms

Class II Vapor Retarder: less than or equal to 1 perm and greater than 0.1 perms

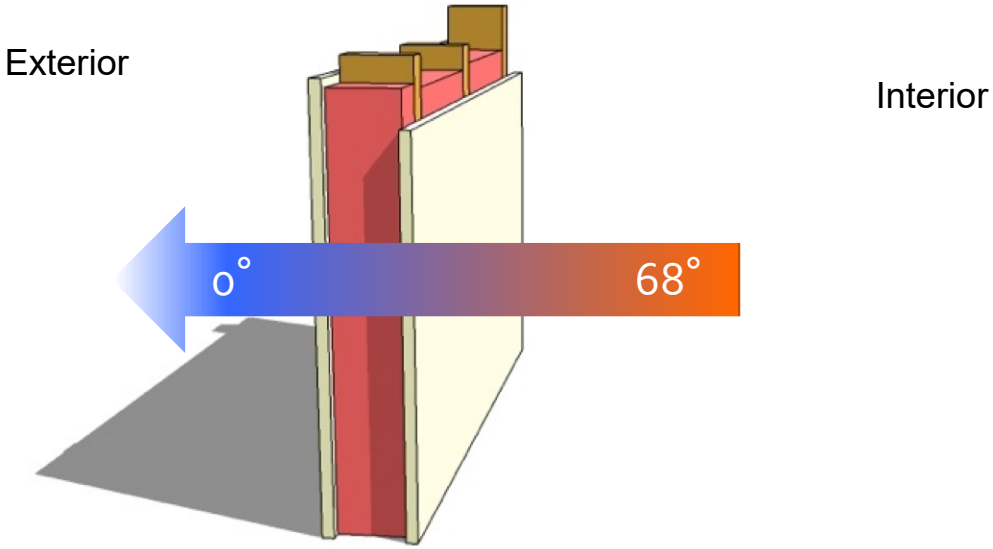
Vapor III Vapor Retarder: greater than 1 perm but less than 10 perms

Product permeability

Perm Rating	Product	Use
40	Vinyl siding	VP
40	Brick veneer	VP
30	Building felt paper	VP
10?	CDX plywood	VSP
5	Housewrap	VSP
2	OSB sheathing	VSP
>1	EPS (Beadboard)	VSP
1	XPS (1” - thickness)	VSP
0.1 - 1	XPS (1” + thickness)	VSP
<0.1	Faced XPS	VI (Barrier)
<0.1	Foil or poly facing	VI (Barrier)

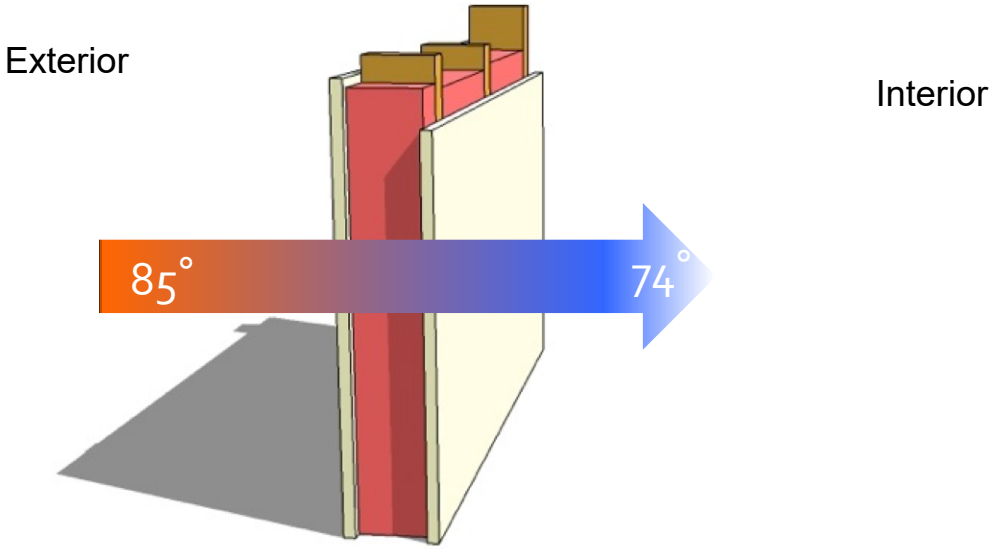
Courtesy Building Science Corporation

Where is the dew point? heating



Temperature difference across a wall

Where is the dew point? cooling



Temperature difference across a wall

The problem with cold sheathing

Walls with cold sheathing…

Cavity only
Interior rigid insulation
Zip System sheathing
SIP System construction
Double Stud

Cold sheathing remains wet if it gets wet

Insufficient exterior XPS sheathing,
dirt floor basement

Heat Flow Management

Reduce convective loss by disrupting fluid motion between a heated object
and the surrounding environment

“Air Seal”

Air Leakage Evaluation

ACH @ cfm50

< 7 is not particularly tight

< 3 achievable is a good job *(Req'd in Zones 3 through 8)*

< 1 really good job!

Passivhaus .6ACH @ cfm50

MSH Green minimum standard
0.25 cfm/SF @ 50 PA

Use Air Barriers

Inside

Interstitial
Somewhere in between

Outside

Air Barrier *System*

Continuous

Stapled, discontinuous paper does not meet air barrier requirements

Strong, Well anchored, Durable, Stiff?

Air Impermeable (Stop air flow)
May be vapor permeable (Allows vapor through)

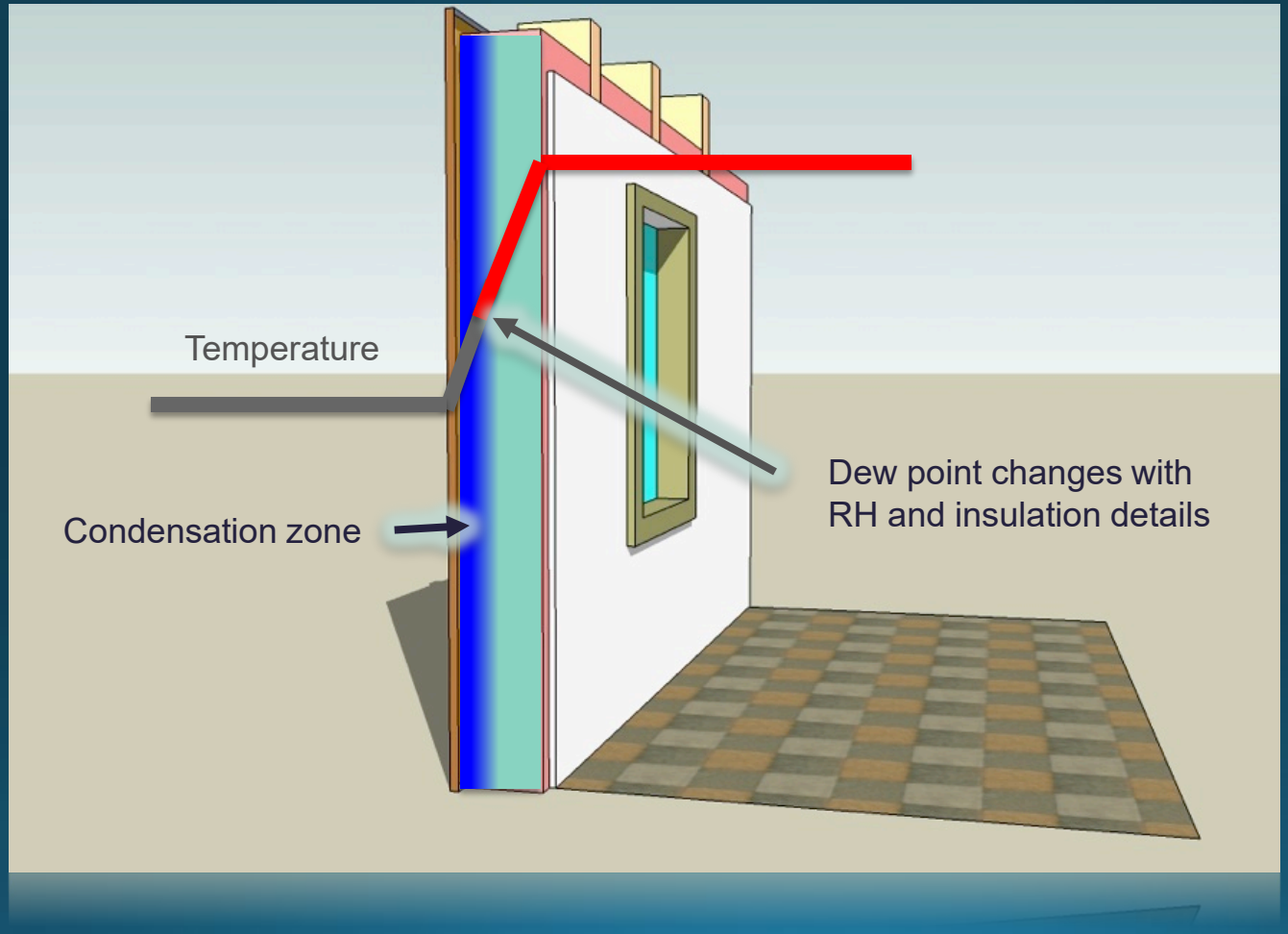
Can serve other functions…

Interstitial

Double Wall System Continuous Tu-tuff™ or other membrane *behind* 1st stud of double stud wall.

(must seal all holes/joints)

Acoustical sealant
at overlaps and
at penetration repairs



Damaging condensation occurs...

When humid exfiltrating air cools down

Diffusing water vapor hits cold surface

Air leakage is critical

Presenter Contact Information

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