Kohta Ueno

Historic Preservation Meets Building Science: The Mallett Deep Energy Retrofit

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ArchitectureBoston Expo®

Overview

The Mallett Deep Energy Retrofit

- The design decision process for how the team chose assemblies and details
- Energy efficiency, durability, constructability

Image c/o Energy Circle

R-Value Targets

Climate Zone	Wall	Vented Attic	Compact Roof	Basement Wall	Exposed floor	Slab edge[1]	Windows (U/SHGC)	Sub-slab[2]
1	10	40	35	5	10	none	yes	none
2	15	50	40	10	20	5	0.35/<.25	none
3	20	50	45	10	20	7.5	0.30/<.3	5
4	25	60	45	15	30	7.5	0.30/<.35	7.5
5	30	65	50	15	30	10	0.24/<.50	7.5
6	35	75	60	20	40	10	0.18/--	10
7	40	90	65	25	45	15	0.15/--	15
8	50	100	75	35	50	20	0.15/--	20

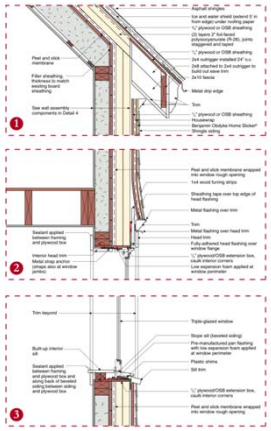
Table 2: Current Recommended "True" Minimum R-value (+/-)[3] including thermal bridging
Source: RR-1005: High R-Value Enclosures for High Performance Residential Buildings in All Climate Zones

- "True" R value: R-13 2x4 wall ≈ **R-8**
  R-19 2x6 wall ≈ **R-12**
- Estimated targets—will vary with local construction costs, energy costs, client targets

Enclosure Design

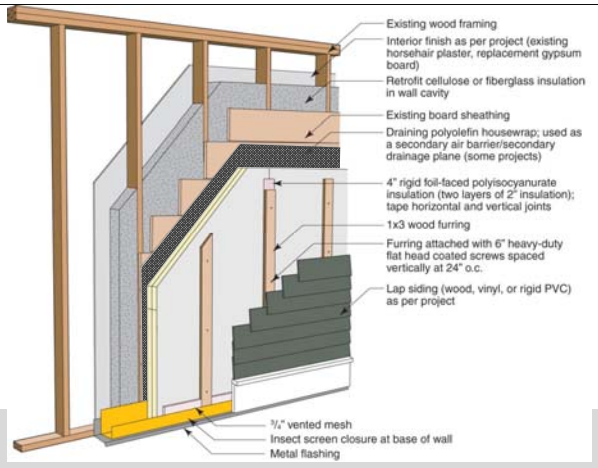
Enclosure Design (1 of 2)

- R-40 Walls
  (existing 2x4 framing filled with cellulose insulation and (2) 2" layers foil-faced polyisocyanurate insulating sheathing on wall sheathing)
- R-50 Roof Insulation
  (existing 2x7 framing filled with cellulose insulation and (2) 2" layers foil-faced polyisocyanurate insulating sheathing on roof sheathing)
- Windows
  (Low-E triple pane krypton filled, U = 0.20 & SHGC = 0.44)



Enlarged Details

4" Polyisocyanurate Foam



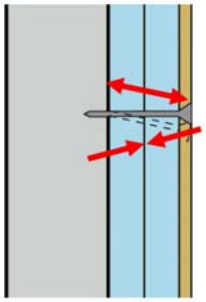
Foam Sheathing Cladding Attachment

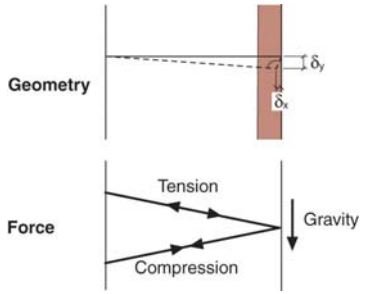
250 lbs/113 kg load (7.8 psf): <0.003" deflection

Wood siding ~2 psf
Fiber cement 2-3 psf
Stucco 8-10 psf

Image c/o Petersen Engineering

Foam Sheathing Cladding Attachment





Rotational resistance provided by tension in fastener and compression of the insulation

See: Exterior Cladding Attachment Research, Peter Baker, EEBA 2012: http://www.buildingscienceconsulting.com/presentations/documents/2012-09-26%20EEBA%20Baker%20Cladding%20Attachment.pdf

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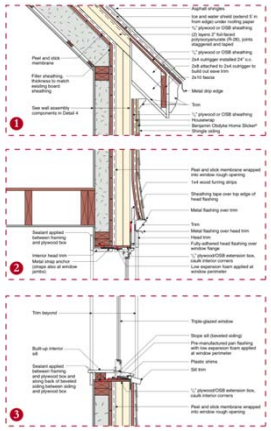

Enlarged Details

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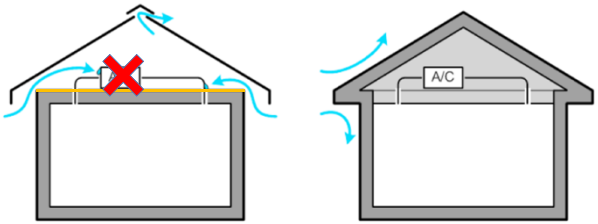
Vented and Unvented Roofs



(Conventional) Ventilated Attic — Unvented Cathedralized Attic

- Vented roofs good solution for low cost, durable, high-R assembly, IF:
  - No mechanicals in vented roof AND
  - Good air barrier at attic floor

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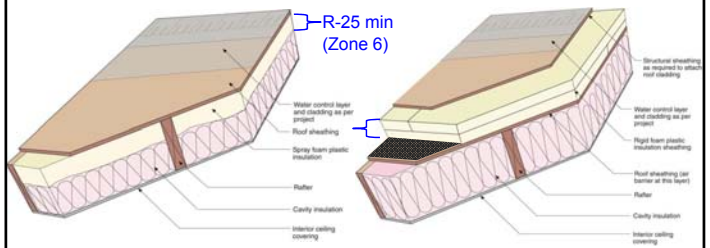
Unvented Roof: How?



- 2006 IRC: R806.4 Unvented attic assemblies
- Minimum R-value of "air impermeable insulation"
- Nail base needed with rigid foam on roof deck
- Air barrier on interior side of "roof sandwich"

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Enclosure Design (1 of 2)

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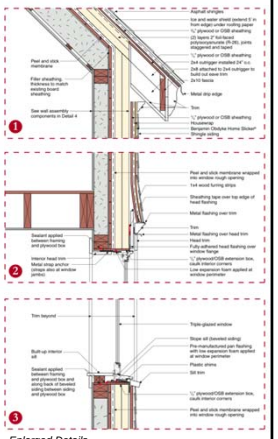

Enlarged Details

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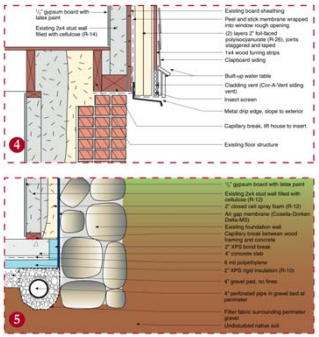
Water Control: Pan Flashings

- Deep energy retrofits (addition of insulation at existing wall) can make the wall more vulnerable to water leakage
- Previously "survivable" leaks may no longer be able to dry out.

Enclosure Design (2 of 2)

- R-24 Basement Walls
  (2" closed cell spray foam with 2x4 stud wall filled with cellulose)
- R-13 Rim Joist Area
  (2" closed cell spray foam with 2x4 stud wall filled with cellulose)
- R-10 Basement Slab
  (2" XPS below slab)



Enlarged Details

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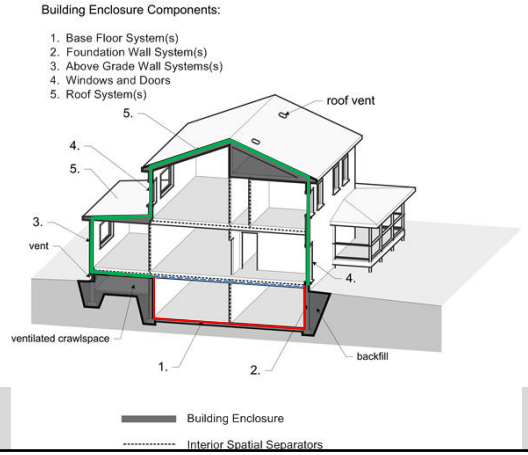
Basement Insulation Location



Basement Insulation Location

- 4.6 ACH50; 2129 CFM 50 total; 1100 CFM 50 through floor
- 8.5 ACH50; 3590 CFM 50 total; 1740 CFM 50 through floor

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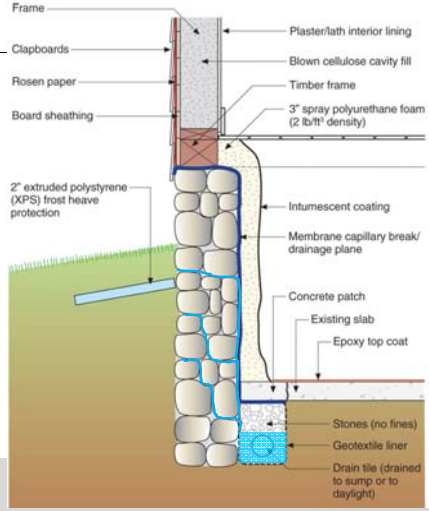
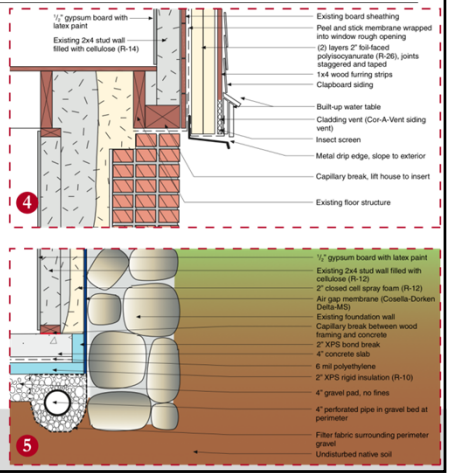


Foundation Insulation Details

- Stud wall and cellulose insulation for additional R-value
- 2" XPS sub-slab insulation



Air Barriers

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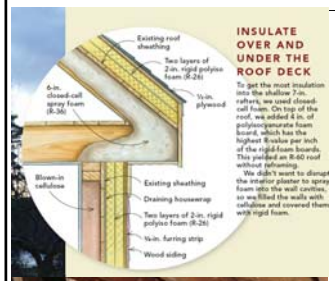
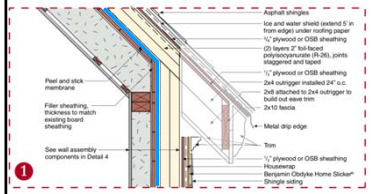
Roof-to-Wall Air Barrier Connection



"Chainsaw" Retrofits (Roof-to-Wall)



See "The History of the Chainsaw Retrofit" (Green Building Advisor)
http://www.greenbuildingadvisor.com/blogs/dept/musings/history-chainsaw-retrofit

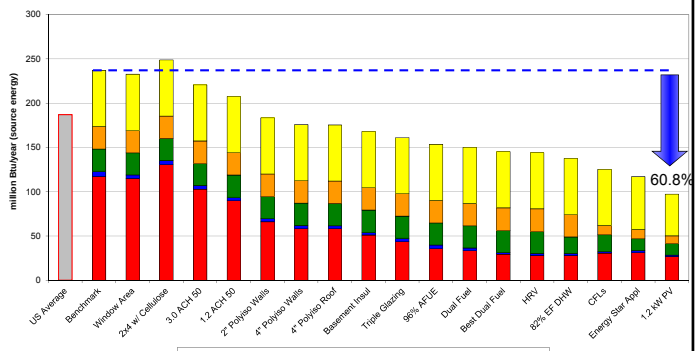
Wall Retrofit Air Barrier Options

Self-adhered Membrane as Air Barrier

- 69 CFM 50 (0.09 ACH 50) w. blanked off openings
- 337 CFM 50 (0.4 ACH 50) pre-drywall

Energy Performance

Parametric Simulation Loads



Graph shown as source energy (million Btu/year)

Simplified Mechanicals

Mini-Splits (DHPs)

Mini-split non-ducted head

- Both heating & cooling
- Multi-splits (single outdoor unit)
- Systems with SEER=26 and HSPF=11 available

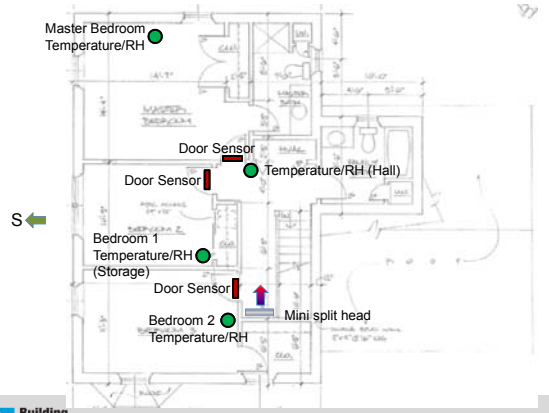
Mini-split short ducted system

Mini-split outdoor unit

Mini-Splits Heating/Cooling in Cold Climate

- 1818 sf house, solar-oriented, superinsulated (12" spray foam walls, R-80 roof), triple glazed windows, very airtight
- Central Massachusetts location
- Net zero performance

Mini-Split Heat Pumps



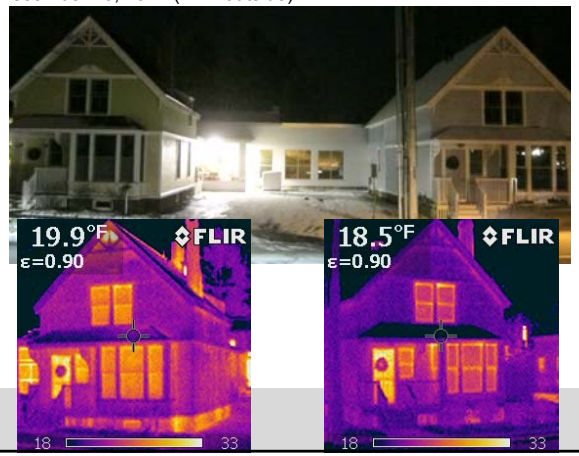
Mini Split Heating Research Conclusions

- Single point heating per floor can keep rooms close to setpoint (~5-7° F)
- Deep heating setbacks cause greater differences
- Leaving doors closed increases temperature differences
- Deep setbacks result in long runtimes for mini split heat pumps
- "Acceptable sizing" data inconclusive, but other practitioners in colder climates have hard data
- Effective trade-off for superinsulated enclosure

Infrared Images

Infrared Images

- December 26, 2012 (27 F outside)



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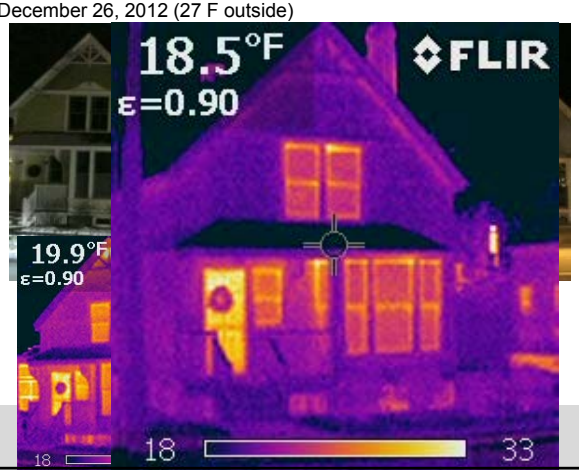

Infrared Images

Snow Melt Patterns

- One of these things is not like the other…

Questions?

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