

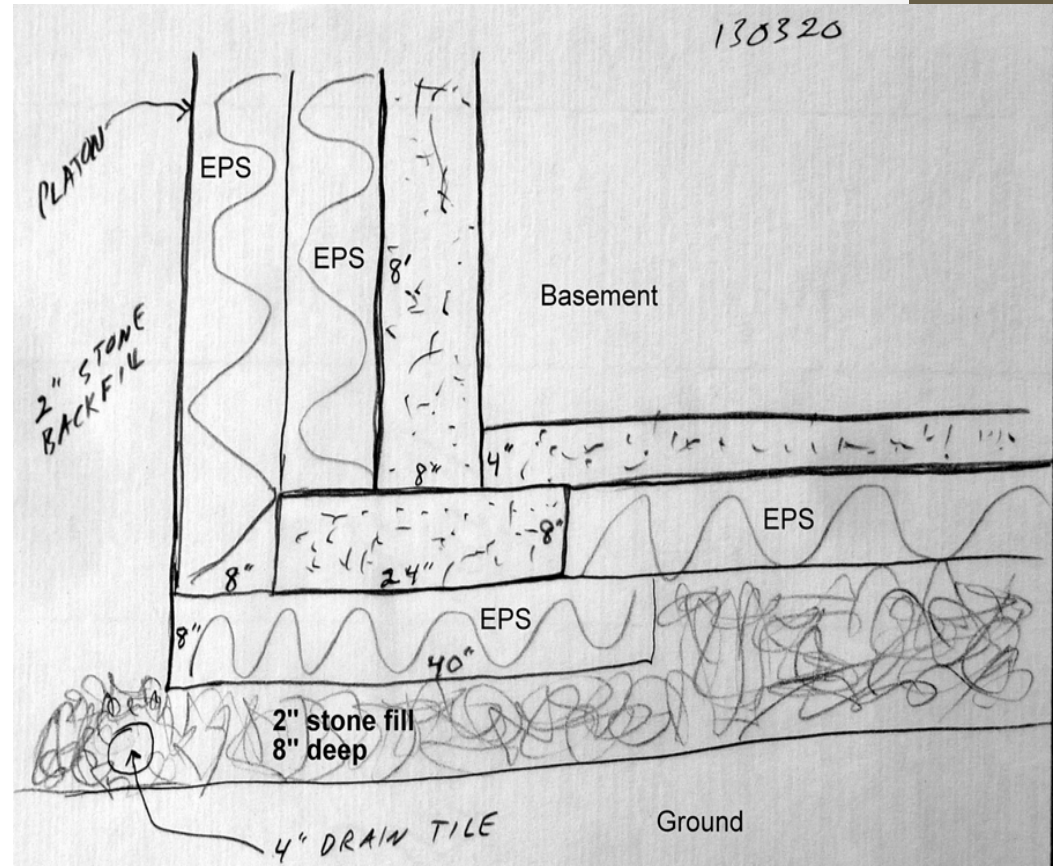
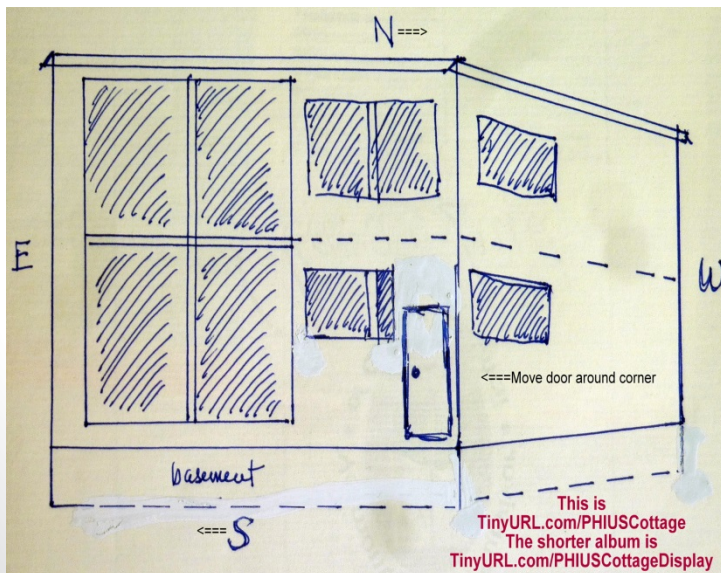
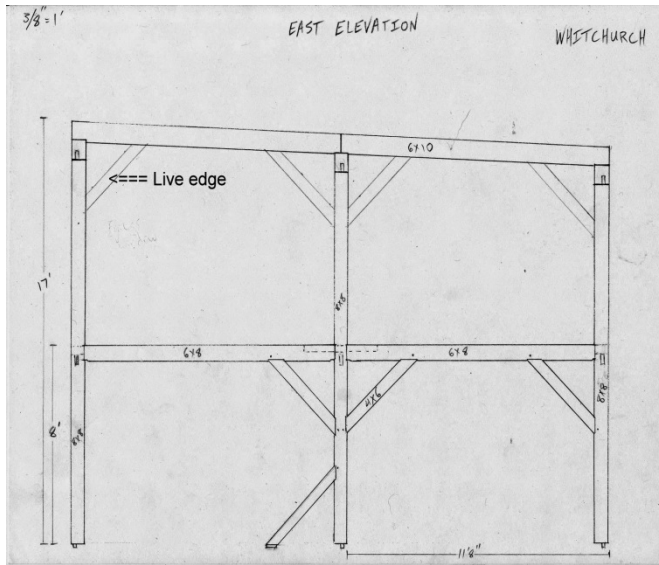
Whitchurch Passive House Cottage

Middlesex VT



2014/6/22 12:59

Design Brainstorming



Design/Build Team Goals

- Sustainable, Robust and Resilient assemblies



Sustainable Locally milled Lumber



Timber Frame Raising





Hemlock air dried frame



Design/Build Team Goals

- Sustainable, Robust and Resilient assemblies
- Energy Modeling – PHPP- Therm - WUFI

Passive House Verification

Building		Whitchurch Passive House Cottage	
Location and County		Montpelier, VT	
Street Address		Brook Rd	
City, State, Zip		Middlesex	
Country		USA	
Building Type		Timber Frame	
Home Owner(s) / Client(s)		Greg and Barb Whitchurch	
Street Address		Brook Rd	
City, State, Zip		Middlesex, VT	
Architect		Greg Whitchurch, Chris Mikeic, Indigo Ruth-Davis	
Street		105 Camp Rd, PO Box 22	
City, State, Zip		Colchester, Vermont 05449	
Mechanical System		CERV, by Build Equinox	
Street Address			
City, State, Zip			
Year of Construction		2013	
Number of Dwelling Units		1	
Gross Enclosed Volume $V_{G, \text{enc}}$		211.30 m ³	
Number of Occupants		3.8	
Interior Temperature		68.0 °F	
Internal Heat Gains		0.7 BTU/hr.ft ²	

Energy Demands with Reference to the Treated Floor Area			
Treated Floor Area	1435 ft ²	applied	Monthly Method
Specific Space Heat Demand	3.40 kBtu/(ft ² ·yr)	PH Certificate	4.75kBtu/(ft ² ·yr)
Pressurization Test Result	0.28 ACH ₅₀		0.6ACH ₅₀
Specific Primary Energy Demand (Heating, cooling, Auxiliary and mechanical electricity)	33.1 kBtu/(ft ² ·yr)		38.0kBtu/(ft ² ·yr)
Specific Primary Energy Demand (Heating and electricity electricity)	15.3 kBtu/(ft ² ·yr)		
Specific Primary Energy Demand (Energy Conservation by Heat Electricity)	0.0 kBtu/(ft ² ·yr)		
Heating Load	3.04 BTU/(ft ² ·h)		
Frequency of Overheating	%	over	77.0 °F
Specific Useful Cooling Demand	0.45 kBtu/(ft ² ·yr)		4.75kBtu/(ft ² ·yr)
Cooling Load	1.98 BTU/(ft ² ·h)		

We confirm that the values given herein have been determined following the PHPP methodology and based on the characteristic values of the building. The calculations are based on:



Calculation Electricity / Internal Heat Gains

Building Type:

Internal Heat Gains:

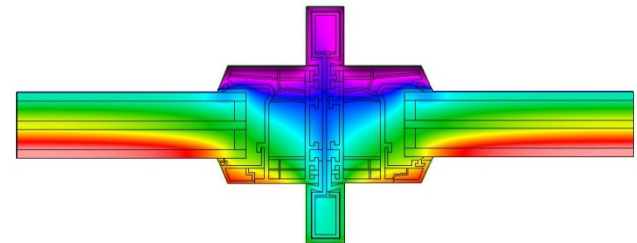
Location:

Type of Climate Data:

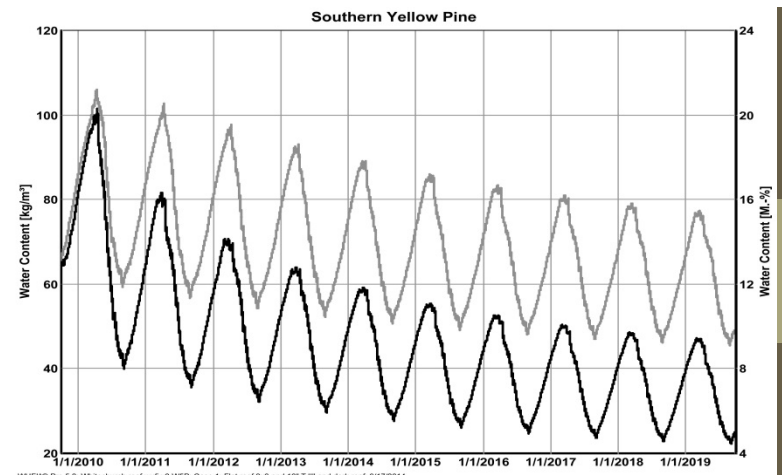
Planned Number of Occupants:

Verification:

Specific Space Heat Demand, Annual Method	3.91
Specific Space Heat Demand, Monthly Method	3.40

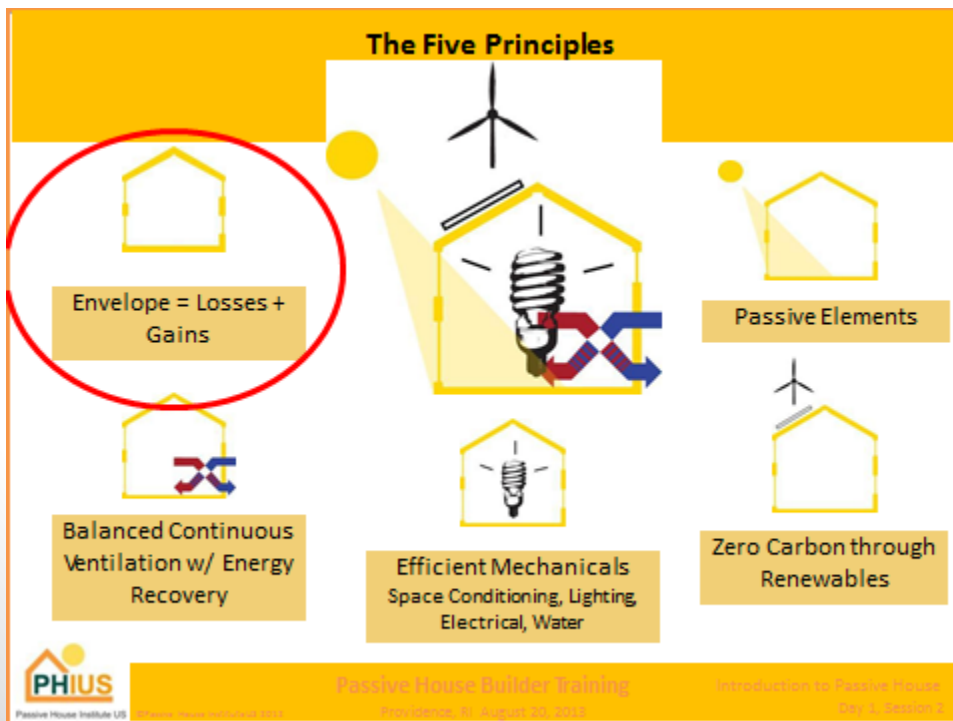


Double-sided mullion THERM



Design/Build Team Goals

- Sustainable, Robust and Resilient assemblies
- Energy Modeling – PHPP- Therm – WUFI
- PHUIS+ Certification



The Five Principles

1 - Envelope

1. Superinsulated
2. Air Tight
3. Thermal Bridge Free

PHIUS
Passive House Institute US

Passive House Builder Training
Providence, RI August 30, 2019

Introduction to Passive House
Day 1, Session 2

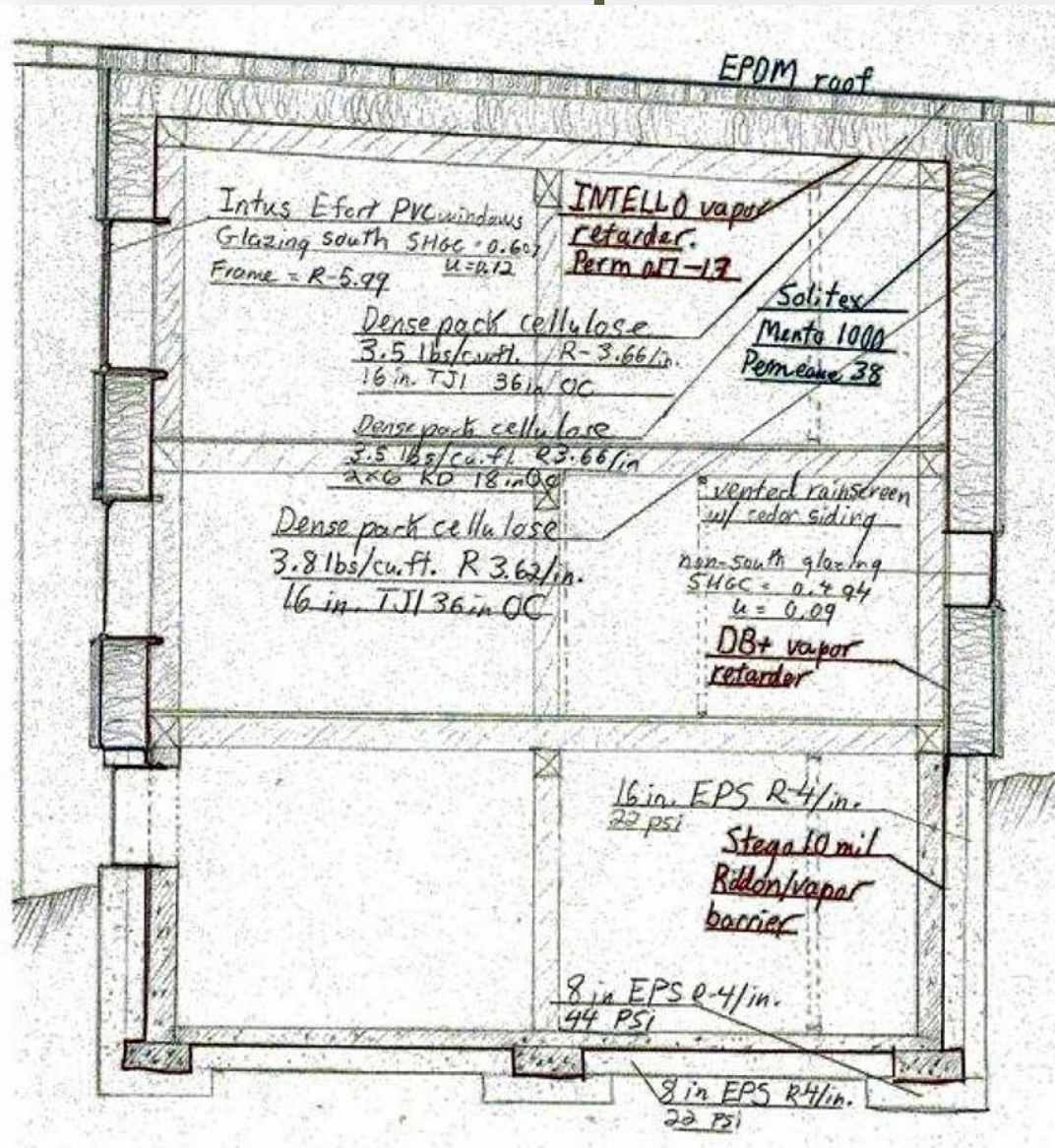
The Five Principles

1 - Envelope

1. Superinsulated
2. Air Tight
3. Thermal Bridge Free



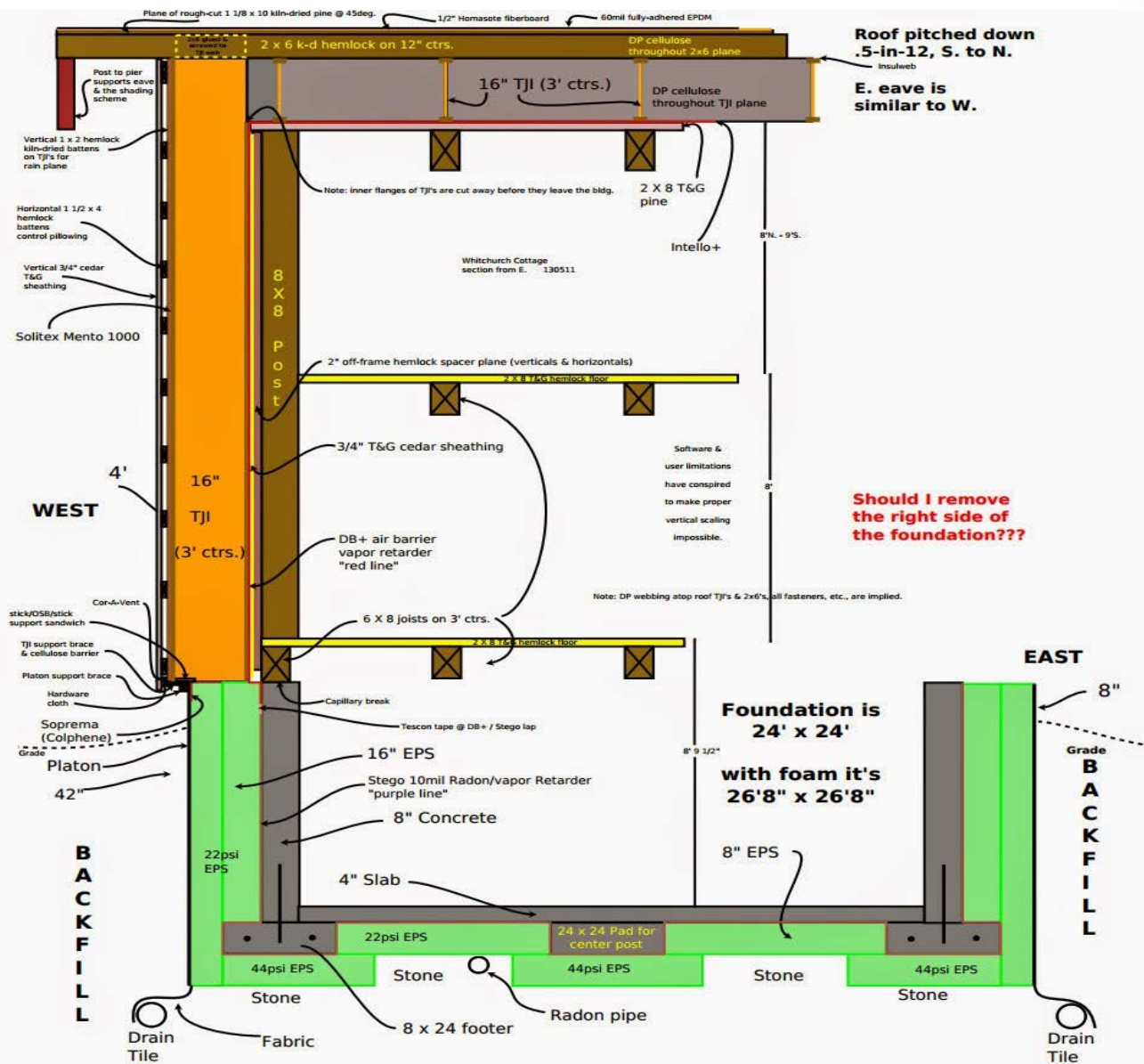
Thermal Envelope



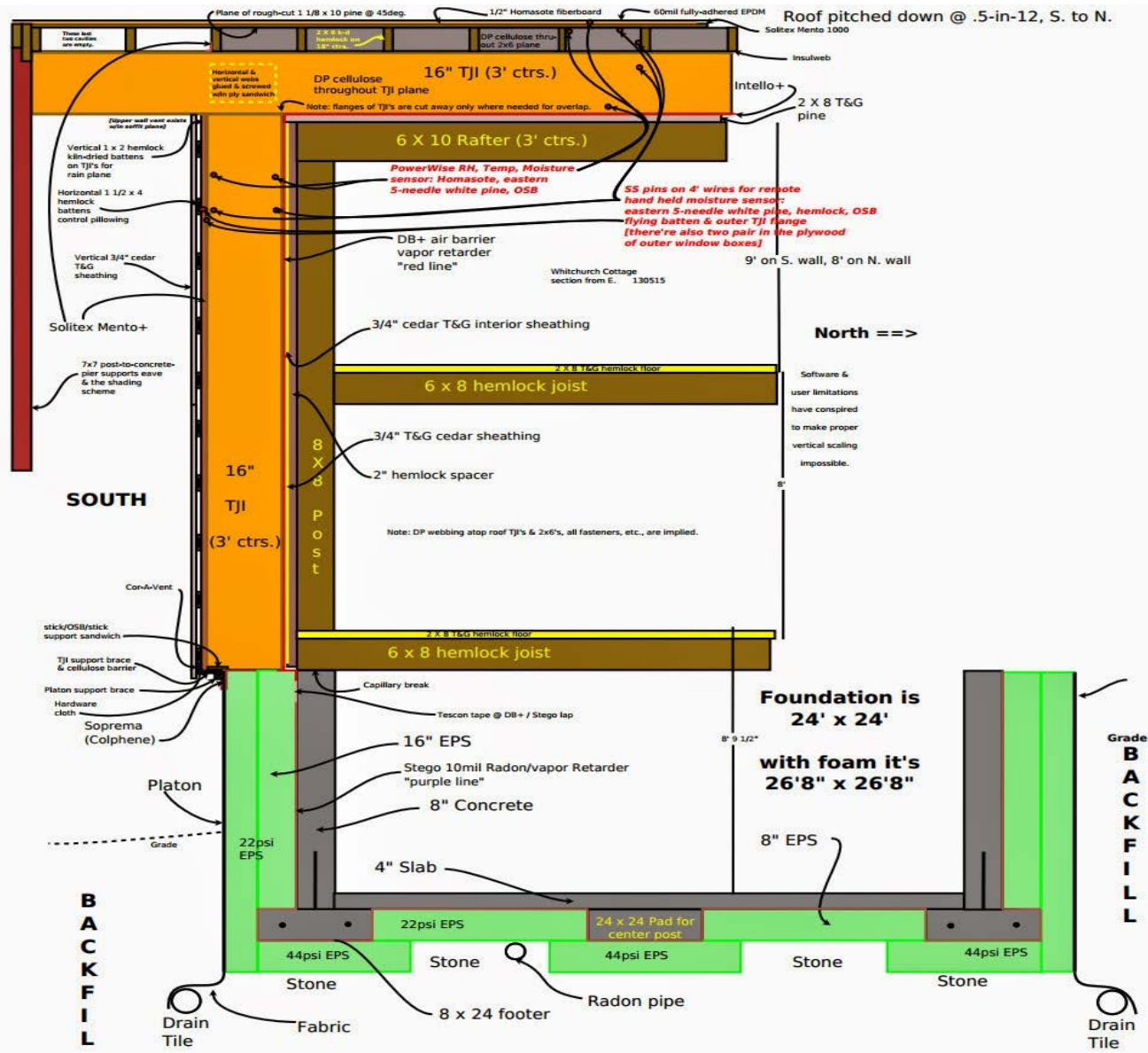
Thermal Envelope R-Values

#	Assembly Description	Total Thickness	R-Value
		in	(hr.ft ² .F/BTU)
1	wall section	16.8	56.2
2	roof	25.0	77.4
3	basment wall	24.0	65.3
4	slab	12.0	33.3
5	footing	16.0	35.9
6	Basement wall	24.0	63.9
7	door	5.5	18.7

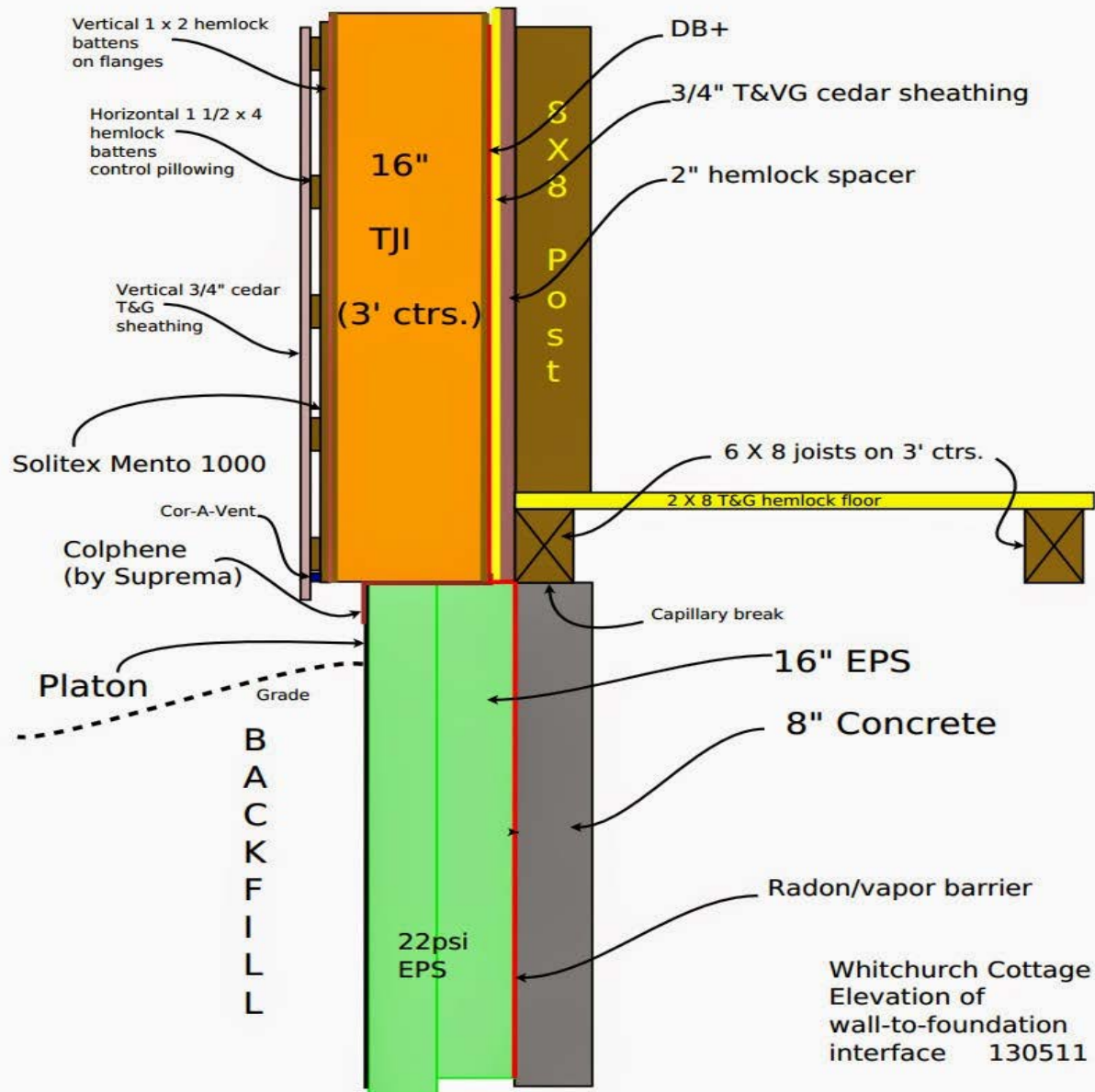
East/West X Section



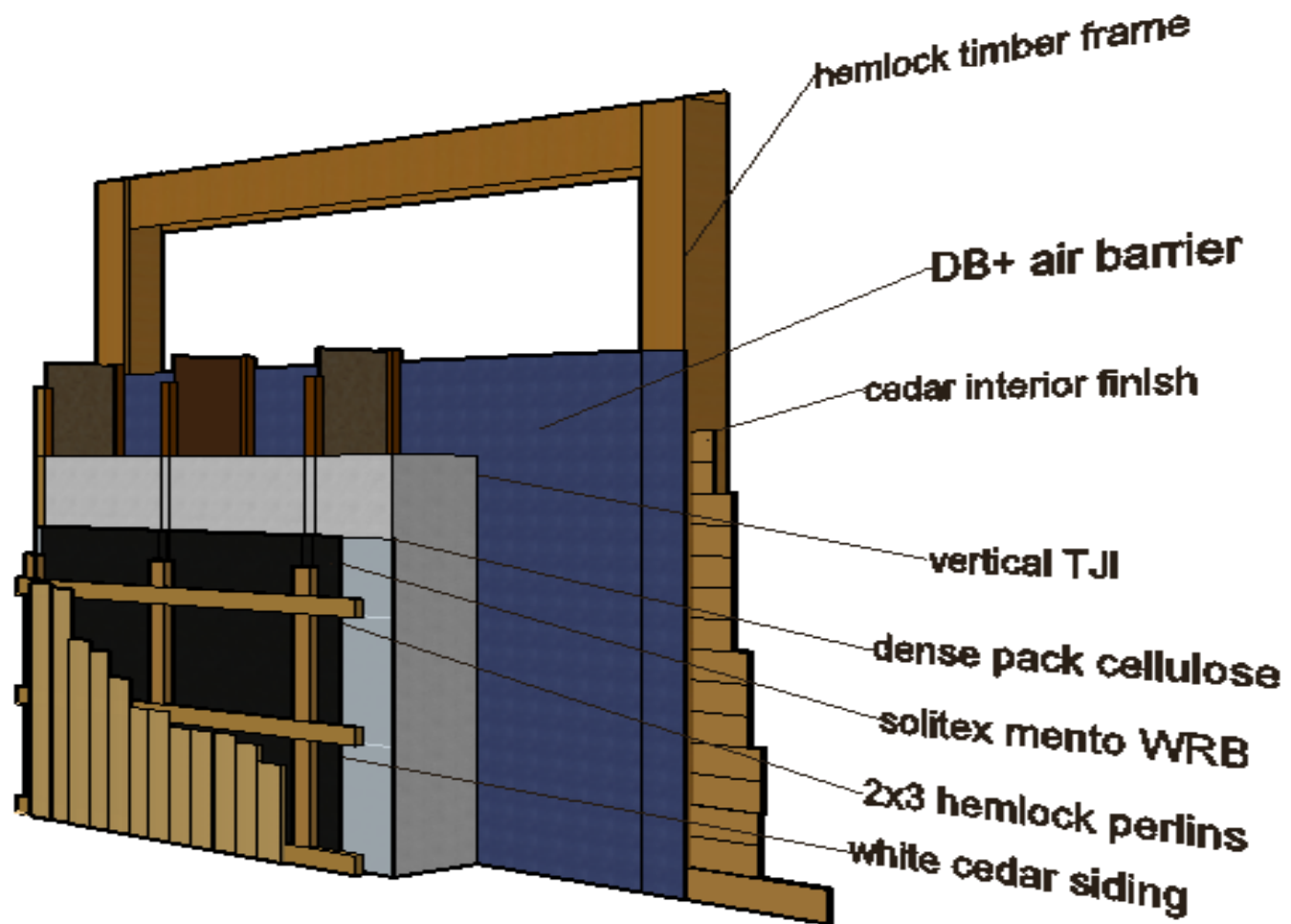
North/South x section



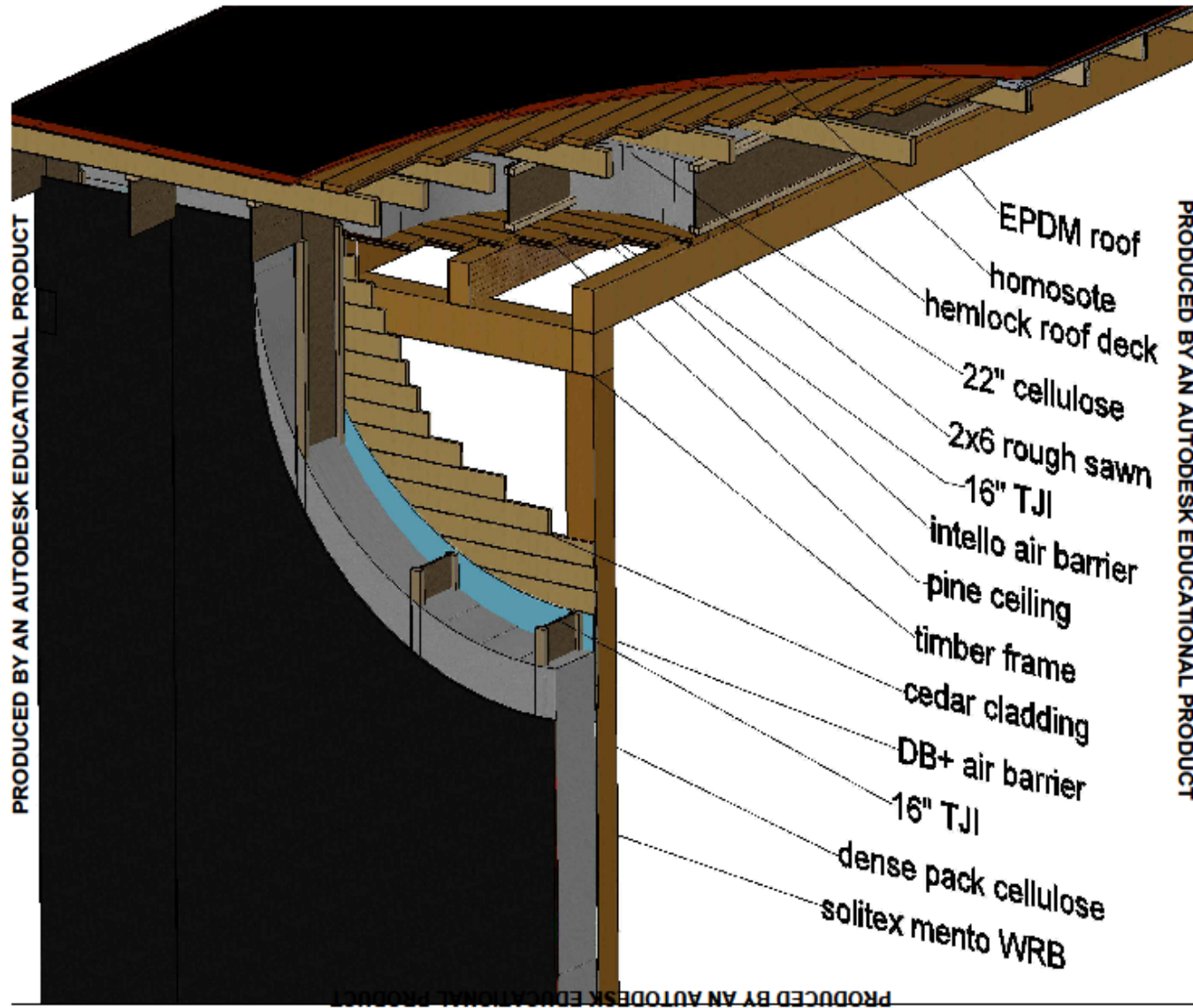
Wall to Foundation



Wall section



Wall to Roof



Heat Demand @ 0.6 ACH 50

Energy Demands with Reference to the Treated Floor Area

Treated Floor Area:

1436 ft²

Applied:

Monthly Method

PH Certificate:

Fulfilled?

Specific Space Heat Demand:

4.01 kBTU/(ft²yr)

4.75kBTU/(ft²yr)

Yes

Pressurization Test Result:

0.60 ACH₅₀

0.6ACH₅₀

Yes

Specific Primary Energy Demand
(DHW, Heating, Cooling, Auxiliary and Household Electricity):

29.0 kBTU/(ft²yr)

38.0kBTU/(ft²yr)

Yes

Specific Primary Energy Demand
(DHW, Heating and Auxiliary Electricity):

14.4 kBTU/(ft²yr)

Specific Primary Energy Demand
Energy Conservation by Solar Electricity:

0.0 kBTU/(ft²yr)

Heating Load:

3.49 BTU/(ft²hr)

Frequency of Overheating:

%

over 77.0 °F

Specific Useful Cooling Energy Demand:

0.77 kBTU/(ft²yr)

4.75kBTU/(ft²yr)

Yes

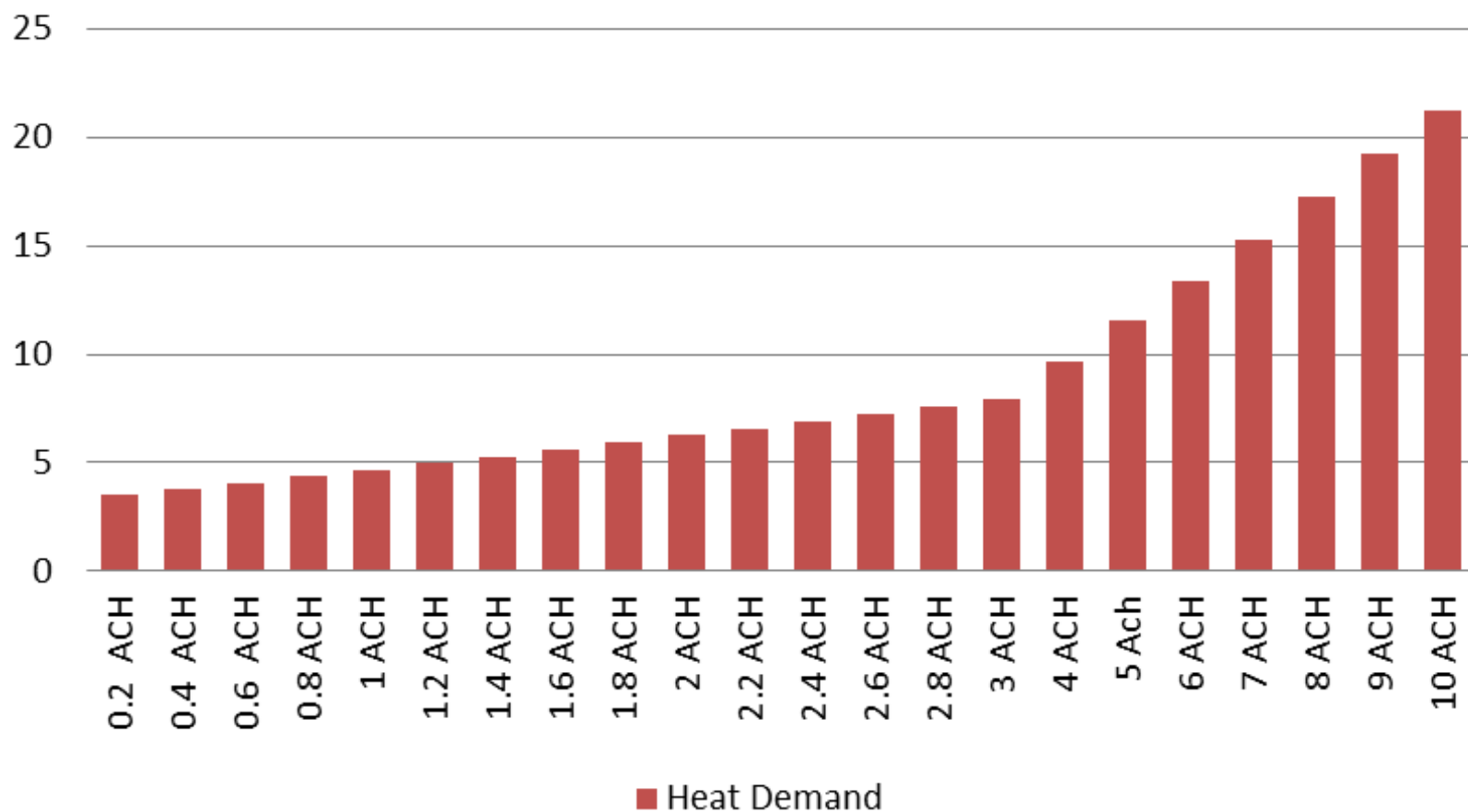
Cooling Load:

2.37 BTU/(ft²hr)

11% reduction Heat Demand @ 0.28 ACH 50

Energy Demands with Reference to the Treated Floor Area				
Treated Floor Area:		1436	ft ²	
	Applied:	Monthly Method	PH Certificate:	Fulfilled?
Specific Space Heat Demand:	3.56	kBTU/(ft ² yr)	4.75kBTU/(ft ² yr)	Yes
Pressurization Test Result:	0.28	ACH ₅₀	0.6ACH ₅₀	Yes
Specific Primary Energy Demand (DHW, Heating, Cooling, Auxiliary and Household Electricity):	29.0	kBTU/(ft ² yr)	38.0kBTU/(ft ² yr)	Yes
Specific Primary Energy Demand (DHW, Heating and Auxiliary Electricity):	14.5	kBTU/(ft ² yr)		
Specific Primary Energy Demand Energy Conservation by Solar Electricity:	0.0	kBTU/(ft ² yr)		
Heating Load:	3.14	BTU/(ft ² hr)		
Frequency of Overheating:		%	over 77.0 °F	
Specific Useful Cooling Energy Demand:	0.77	kBTU/(ft ² yr)	4.75kBTU/(ft ² yr)	Yes
Cooling Load:	2.37	BTU/(ft ² hr)		

Heat Demand at Different Levels of Airtightness



Results

Limit: Air Leakage @ 50 Pa $\leq 0.6 \text{ ACH}_{50}$

Goal: Air Leakage @ 50 Pa $\leq 0.4 \text{ ACH}_{50}$

For a 1500 ft² building with net volume 15,000 ft³

Level	Effective Leakage Area
10 ACH ₅₀	125 in ²
3.0 ACH ₅₀	40 in ²
0.6 ACH ₅₀	8 in ²
0.3 ACH ₅₀	4 in ²

For whole building integrity, know where your holes are!

Note: The Passive House Retrofit standard allows an Air Leakage @ 50 Pa $\leq 1.0 \text{ ACH}_{50}$ due to potential retrofit difficulties



Passive House Institute US

©Passive House Institute US 2012

Passive House Builder Training

Providence, RI, August 22, 2013

Passive House Air-Sealing

Day 3, Session 3



Footer Foam Insulation

8" EPS 44 psi R 4.3/in and concrete R.07/in total R -35.9



Air Barrier-Vapor/Radon Retarder --Ready for Pour

10 ml Stego Plastic sheeting .0254 Perms



Foam Slab Insulation

8" EPS R4/in and concrete R.07/in Total R 34

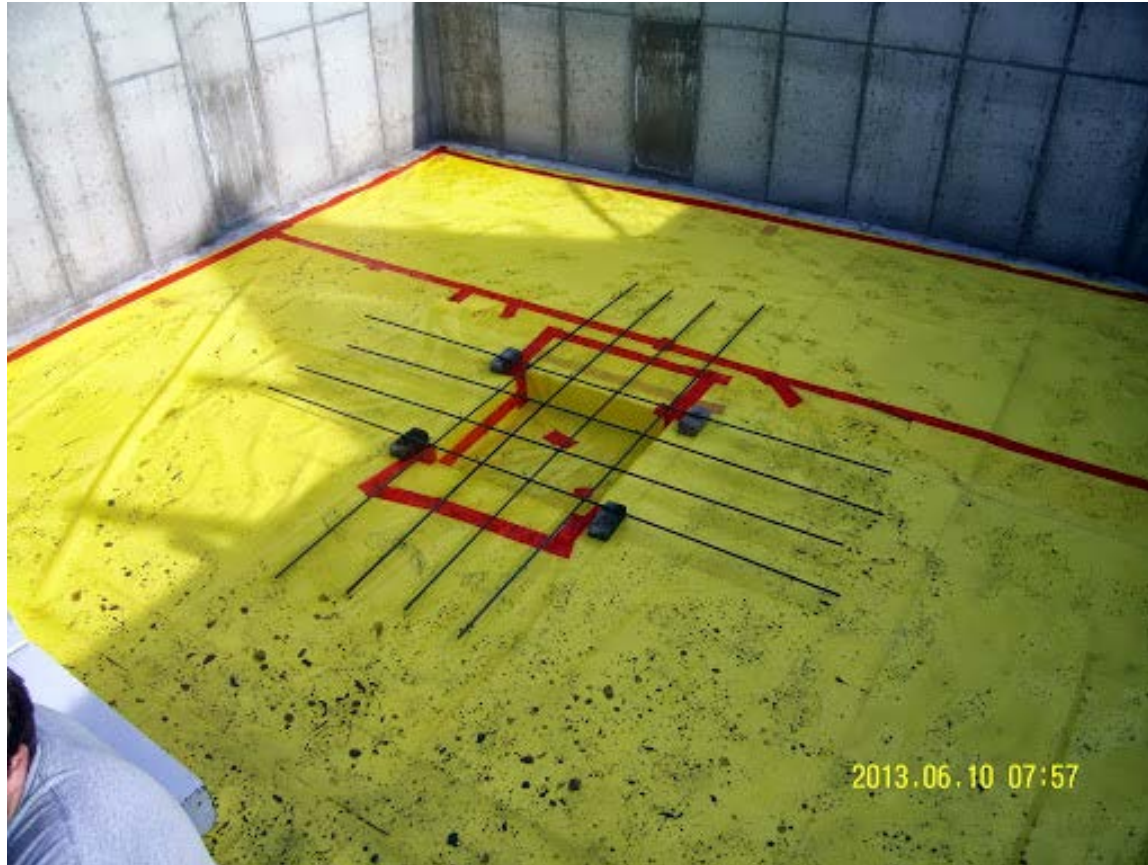


Spray foam the foam !!



Taping the continues ATL-Radon/vapor retarder

Foundation air tightness layer ATL



Slab ATL installed

With reinforced center pad for center post



Foundation Wall ATL

Air seal taped to footer ATL and running up to Timber sill plate



Foundation foam

Walls R-65



Foundation foam



Interior Paneling





Wall Paneling

$\frac{3}{4}$ " KD - T&G White Cedar



Window Buck

$\frac{3}{4}$ " Fir plywood

Un-Vented 22" DP Cellulose Flat EDPM Roof Assembly



Conditions:Pre Certified PHIUS

- [?] The science behind moisture migration and retention and ASHRAE Handbook
- information
- [?] Published data and analysis using WUFI modeling software
- [?] Field data from independent studies performed in similar climates on similar structures
- and assemblies
- [?] The method and care of the installation
- [?] The monitoring plan and implementation observed



Ceiling Paneling –Joint and Seam sealer

2 x 8 KD T&G Pine



Ceiling ATL-Air Barrier-Vapor Control Layer VCL

Highly Variable perm 0.17 Perm to 13.20 Perm



Pressure Activated taping

Done with a "P A D "



Predrill – Tape Air Seal Gasket

16 " TJI



Acrylic Air Sealing caulk

A caulk made of Natural latex ,Tree resin, casein, talc, cellulose and water with Long term elasticity combined with high strength and resistance to tension



6" timber locs

16" OC



Insul-web netting

Separates 2 x 6 upper cavity from TJI cavity below



Roof Deck

KD Pine 5/4 x 10



South Eve

TJI overhang



East Eve

2 x 6 overhang



WRB Bulk Water

24' x 24' WRB Vapor open 38 perm , Class 111 and water closed over insulation envelope

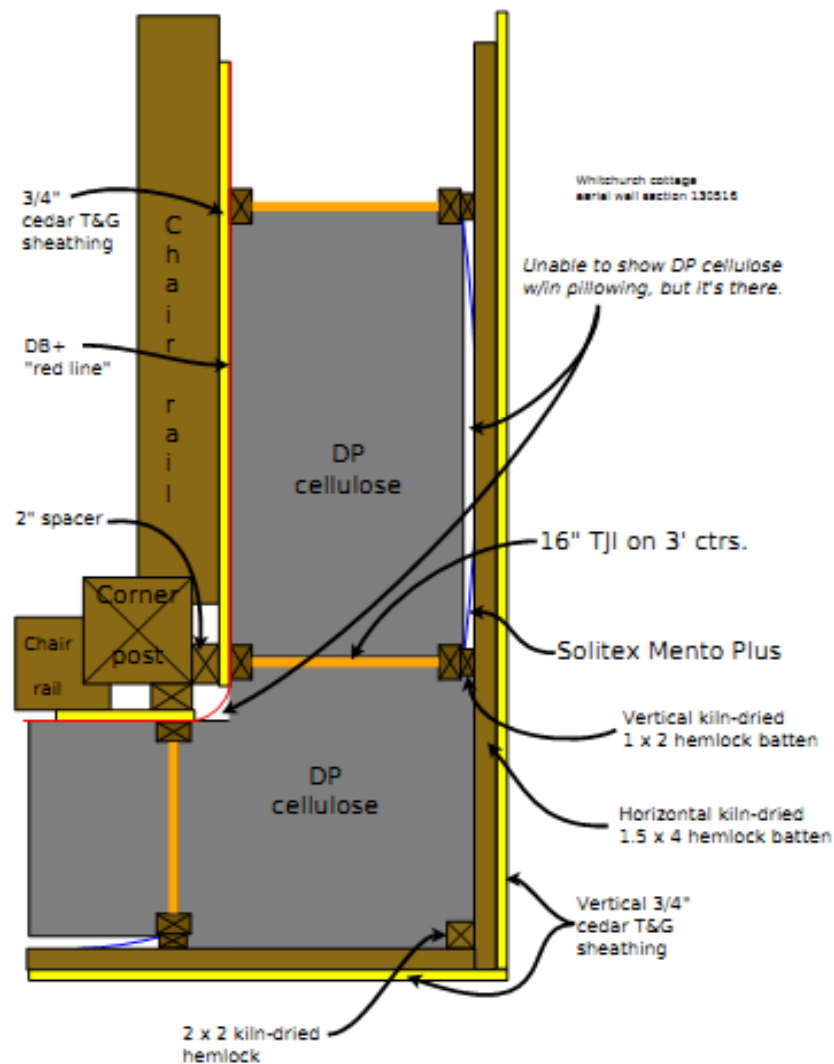


Water Management –Gravel Stop Drip Edge

NW and NE corners

Wall Assembly







Window Bucks --Liquid Applied WRB

Acrylic and vapor open , Applied to outer 6" of Window bucks



Joint and Seam sealer

Acrylic and Vapor open , Applied to Window
Buck seams and TJI attachment locations



Jumping Air barrier from foundation to wall

Used Pro Clima DA-S to jump air barrier from Stego along Sill plate to outside of wall paneling.





Pro Clima DB+

Variable perm ATL Air Barrier and Vapor Control Layer VCL







Taped and ready for TJI









TJI Attachment

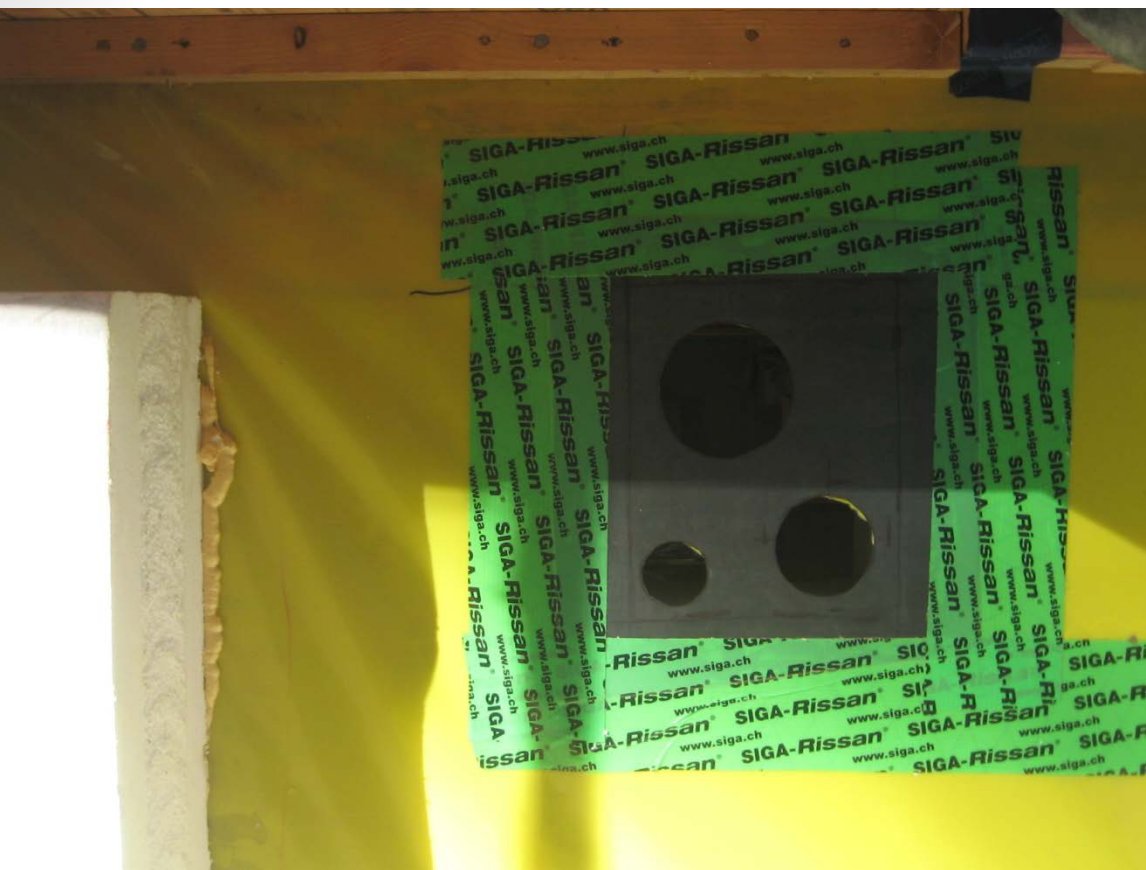
7" Head Locs --









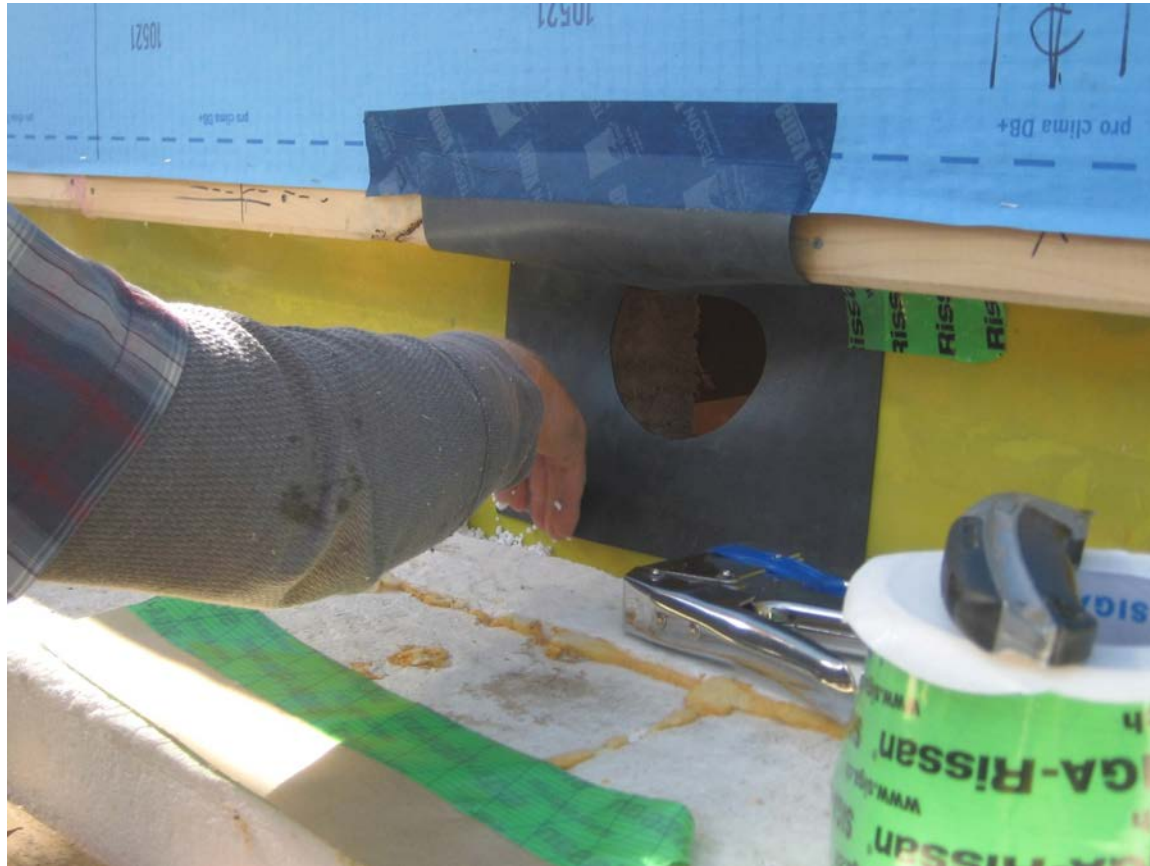


EDPM CUSTOM ROOFING GASKET





Completed Utility Chase Penetrations



CERV Duct Penetrations





Insulated Utility Chase and The Bridge/Skywalk







Utility Chase - Super Insulated-Air tight



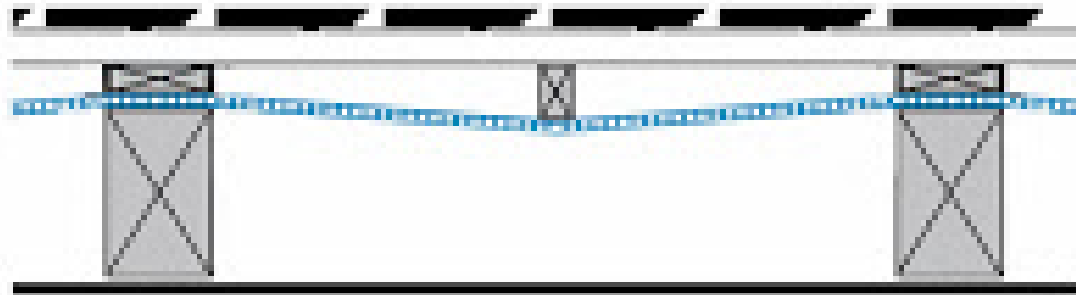


WRB / Vented Rain Plane









Fly-Batten Detail



Pre DP Cellulose & Window Air Leakage Test













1st Air Leakage Test .123 ACH50

26 cfm@50 x 60 / Net Enclosed Volume 12,716 cuft

Cellulose DP Install -- 460 bales
3.8 lbs/cuft.=5.75tons @ 8 day
install









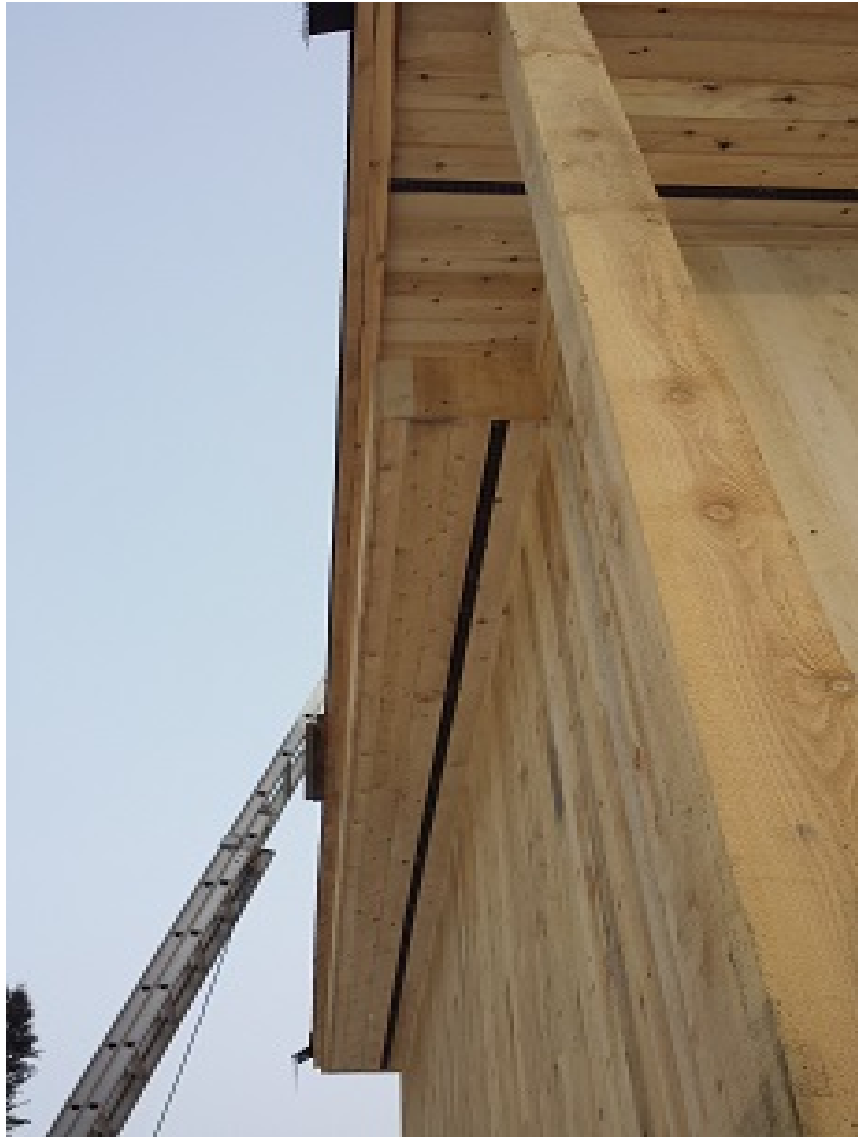
Siding - Soffit Vent - Posts





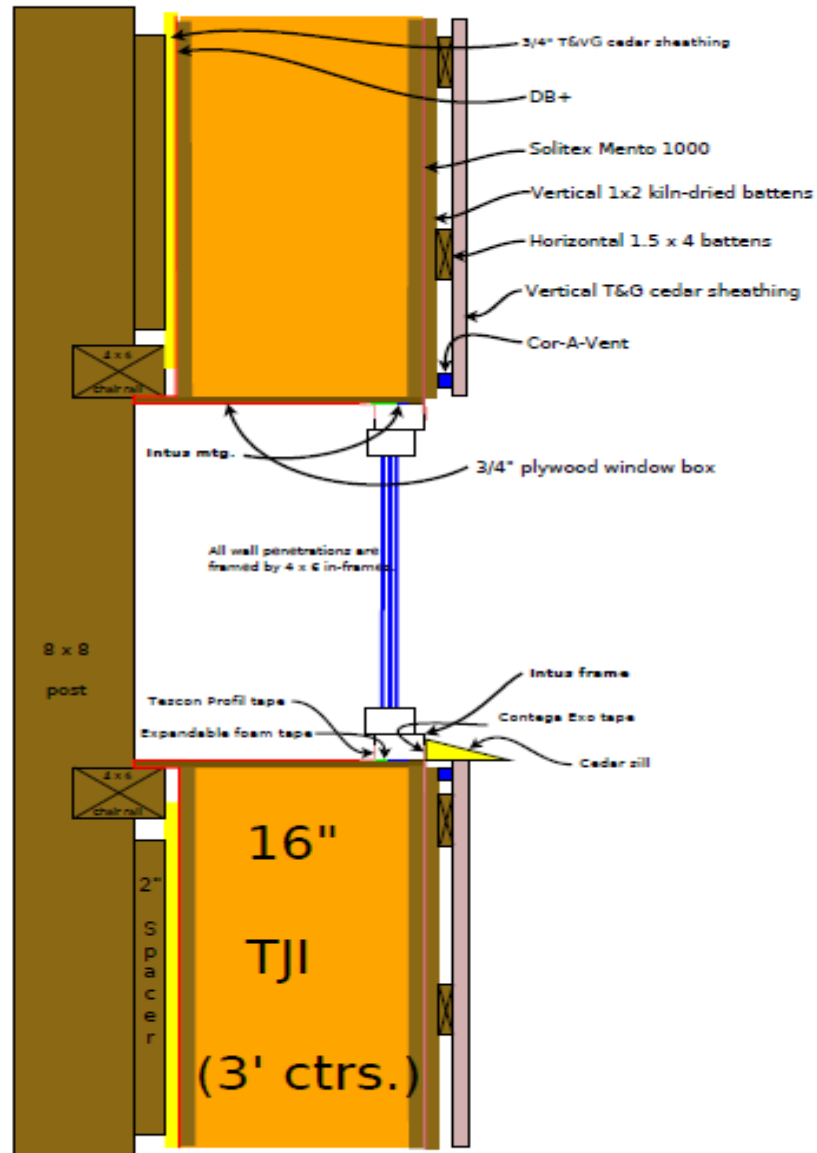


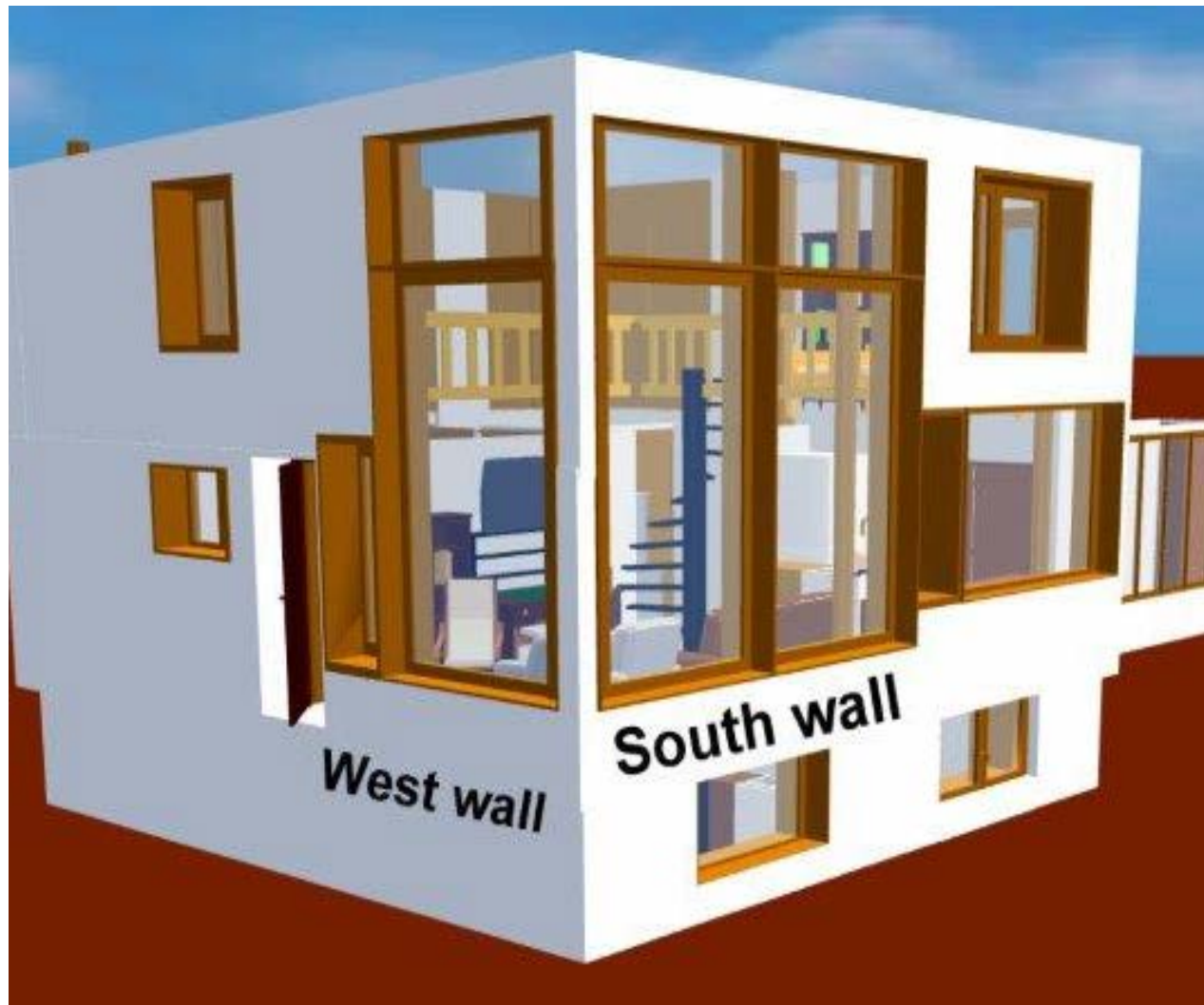
Soffit Venting



Window Delivery







7 x 10 574 lbs.







**Interior
Air seal Taping
Connecting Air
Barrier
Foundation Air
Barrier to
Window
Buck/Bow to
Window**







Window Exterior WRB tapeing





2014/ 5/28 15:56





2014/6/2 12:07

Window sill Pans



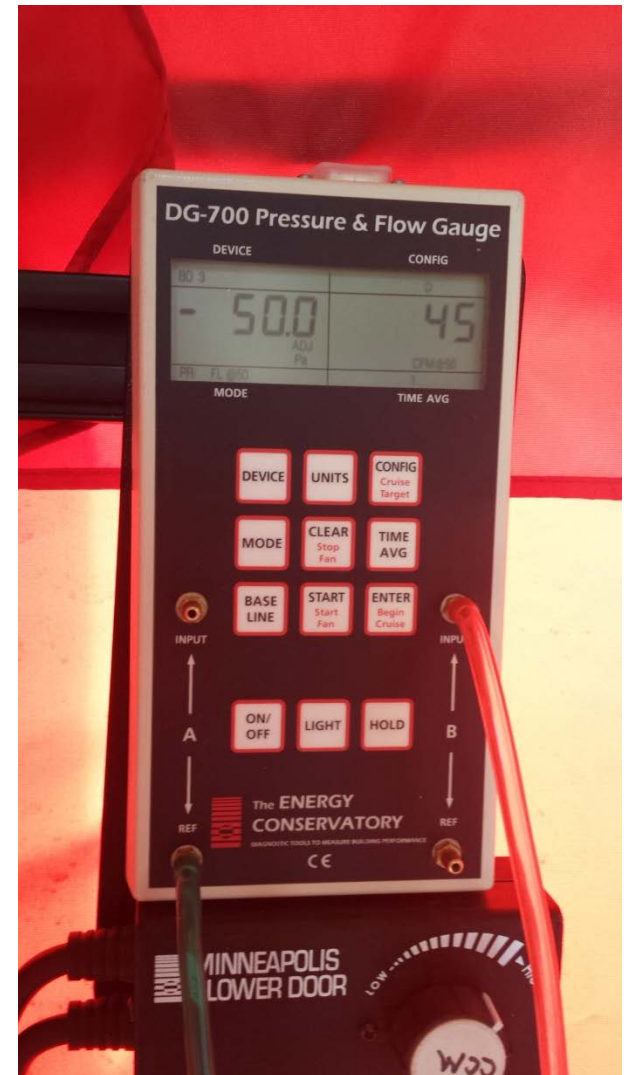
2nd Air Leakage Test

45cfm@50 or .212 ACH50

Post Window Install , Plastic over 2nd
Door opening

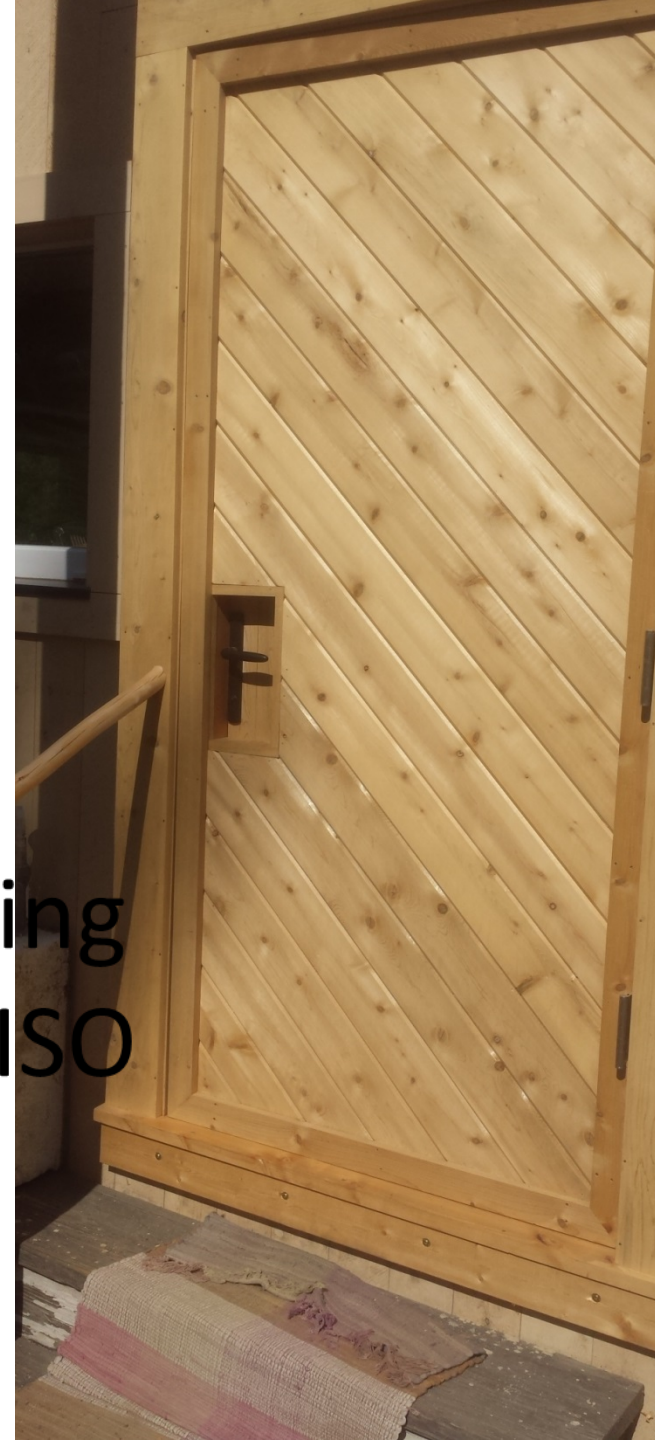
42% increase in airleakage from
window install

19 cfm @ 50 or .089 ACH50





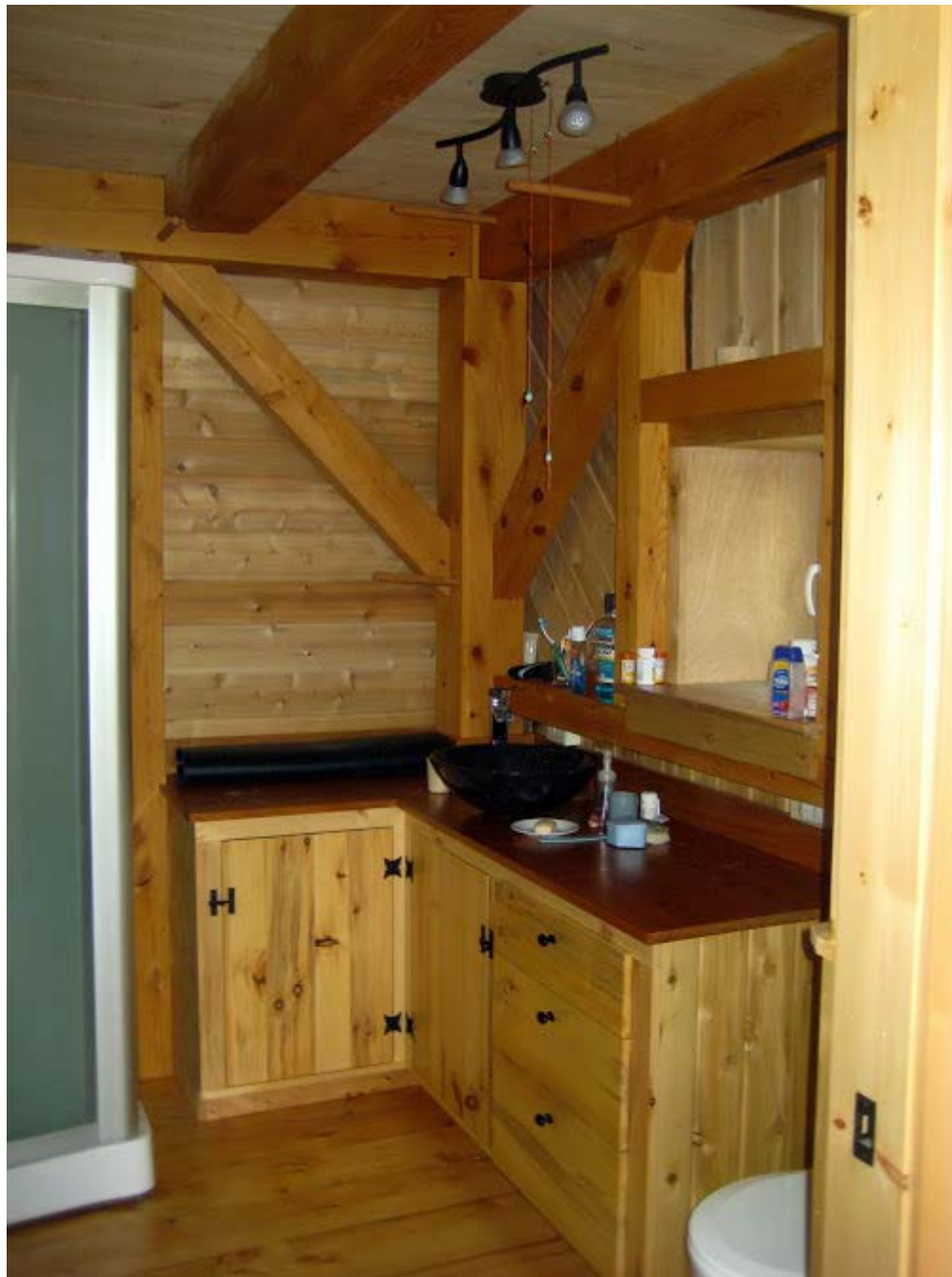
Site built PH
Viking doors
Multi point latching
4" recycled Poly ISO

















North Wall





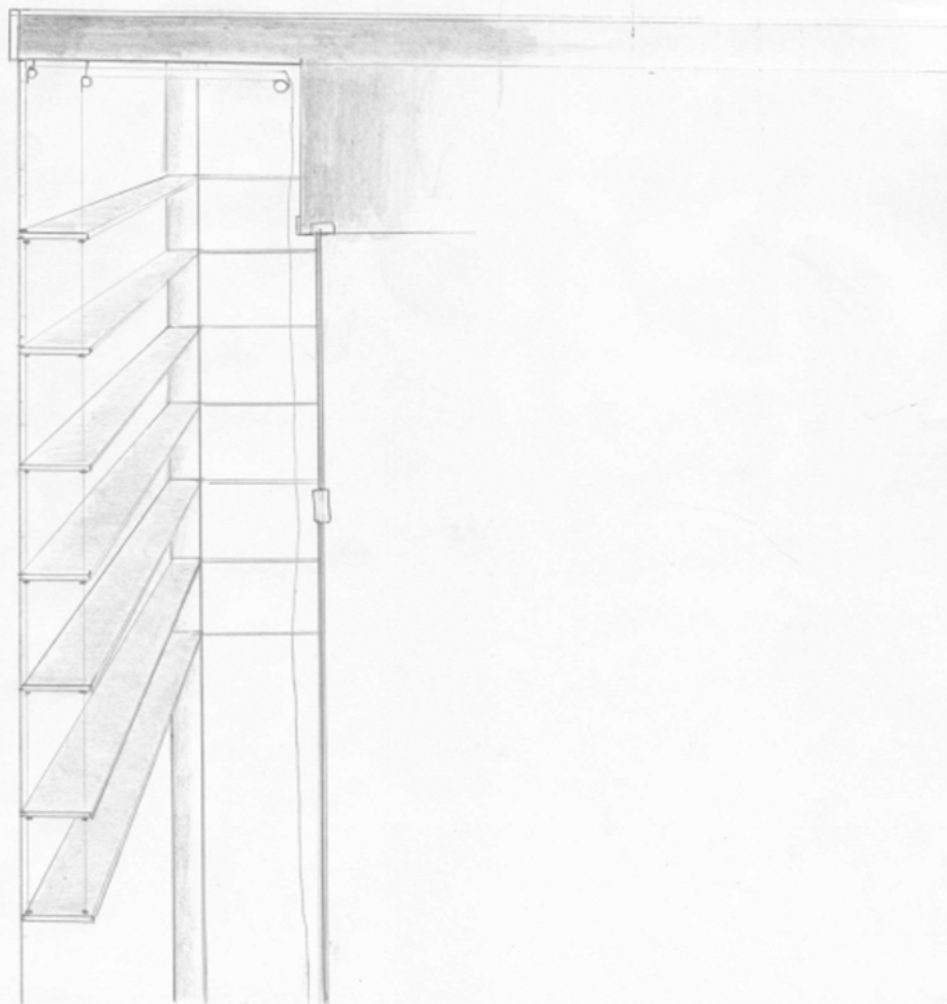
Center Roof Sensor Location







Perspective looking west along south
facade





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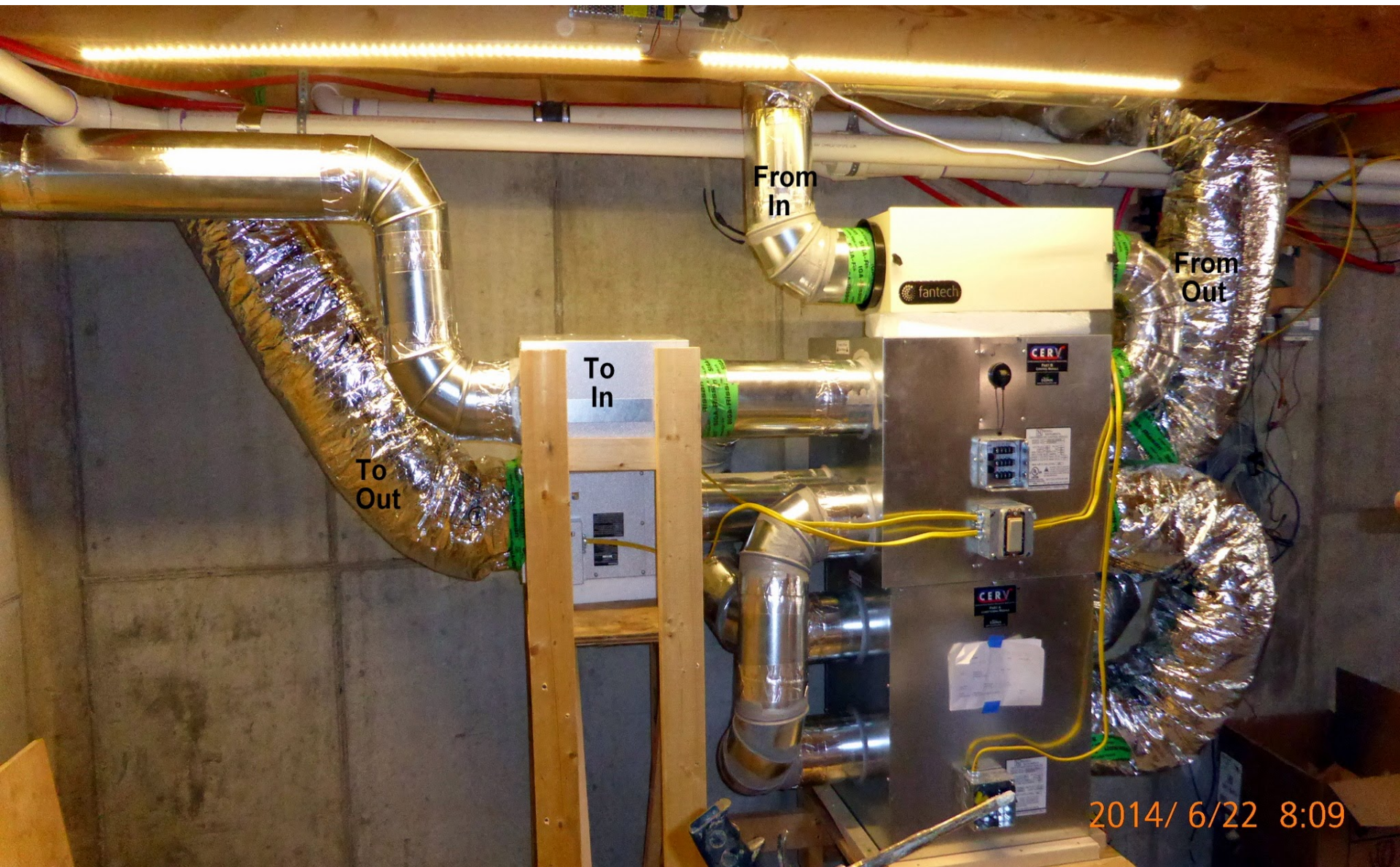
Final RESNET Testing Day !!!



8	Optional preliminary blower door test (manual or automated test)	
8.1	Passive House Volume	12625
8.2	CFM50 test result - depressurization	26
8.3	ACH50 - depressurization	0.12
8.4	CFM50 test result - pressurization	0
8.5	ACH50 - pressurization	0.00
8.6	Average CFM50	13
8.7	Passive House ACH50	0.06

9	Final blower door test		
9.1	Passive House Volume	12625	
9.2	CFM50 test result - depressurization	47	
9.3	ACH50 - depressurization	0.22	
9.4	CFM50 test result - pressurization	71	
9.5	ACH50 - pressurization	0.34	
9.6	Average CFM50	59	
9.7	Passive House ACH50	0.3	Pass
9.8	Testing reports from automated testing software (typically, Tectite or Fantestic) included in documentation folder		y

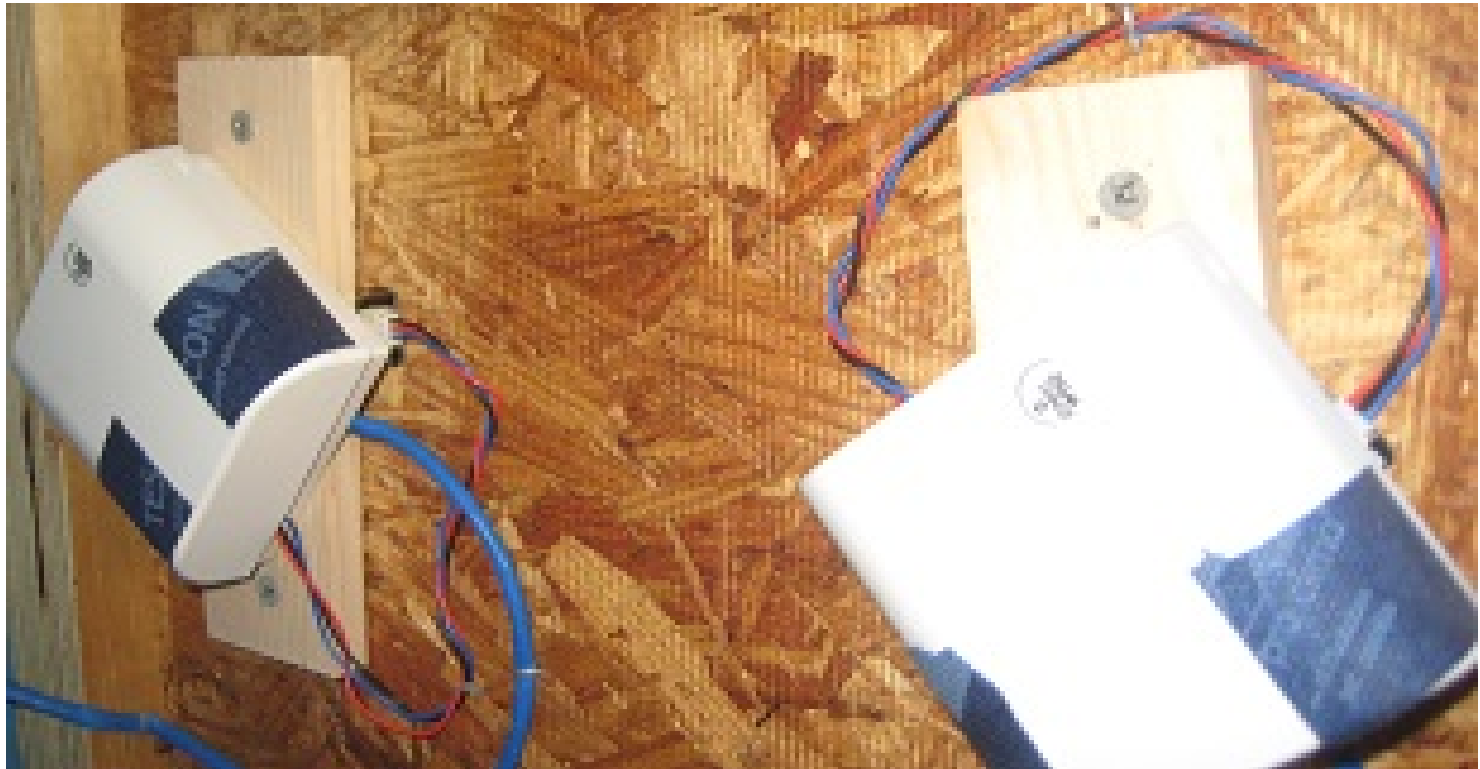




CERV ERV

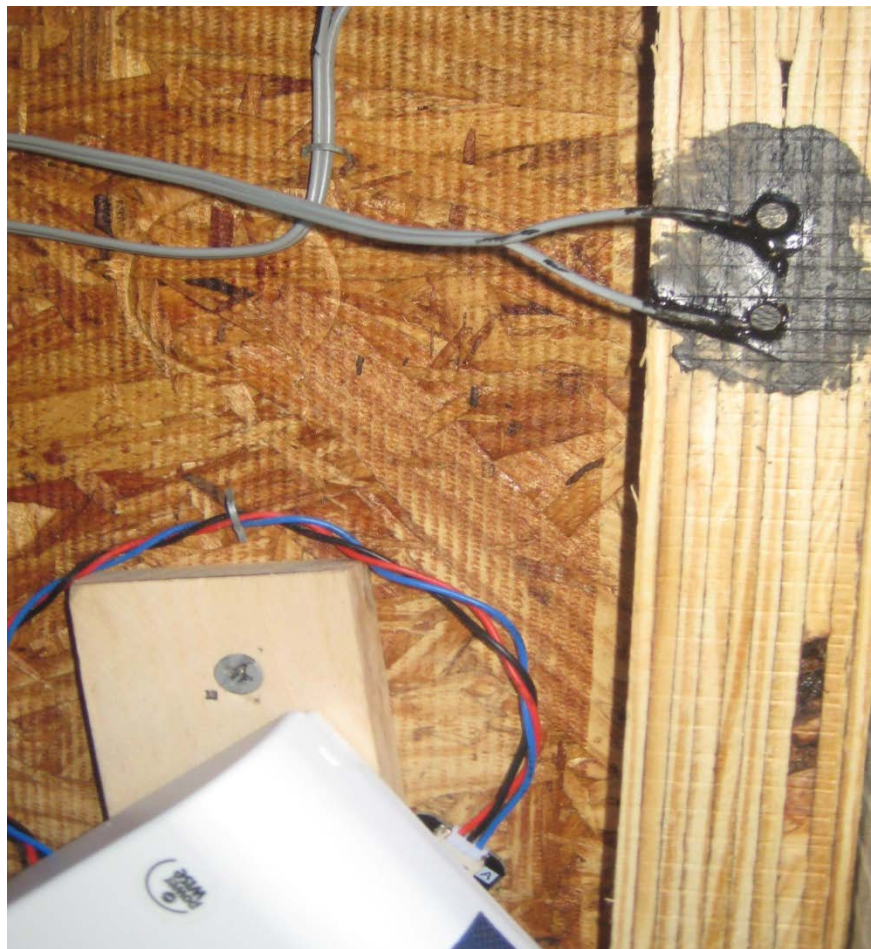


Wall Sensors and Moisture Meter Extensions



North Wall







South Wall







Roof Sensors





Powerwise Board

RH, Temp and Moisture probe imbedded in fiber board layer







Homosote Fiber board

½" base layer for EDPM roof



Sensor locations

Looking north east

DP Cellulose Roof Envelope Sensors and Moisture Meter Extensions

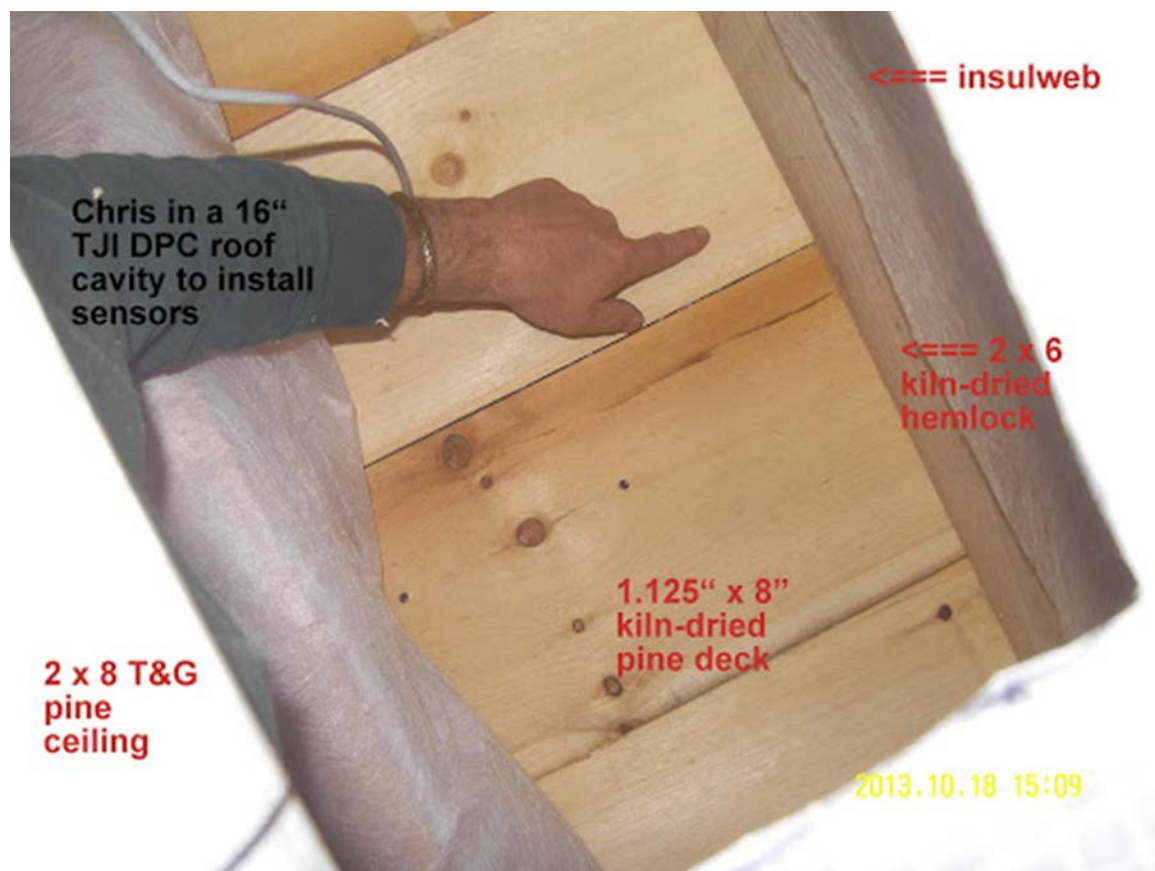


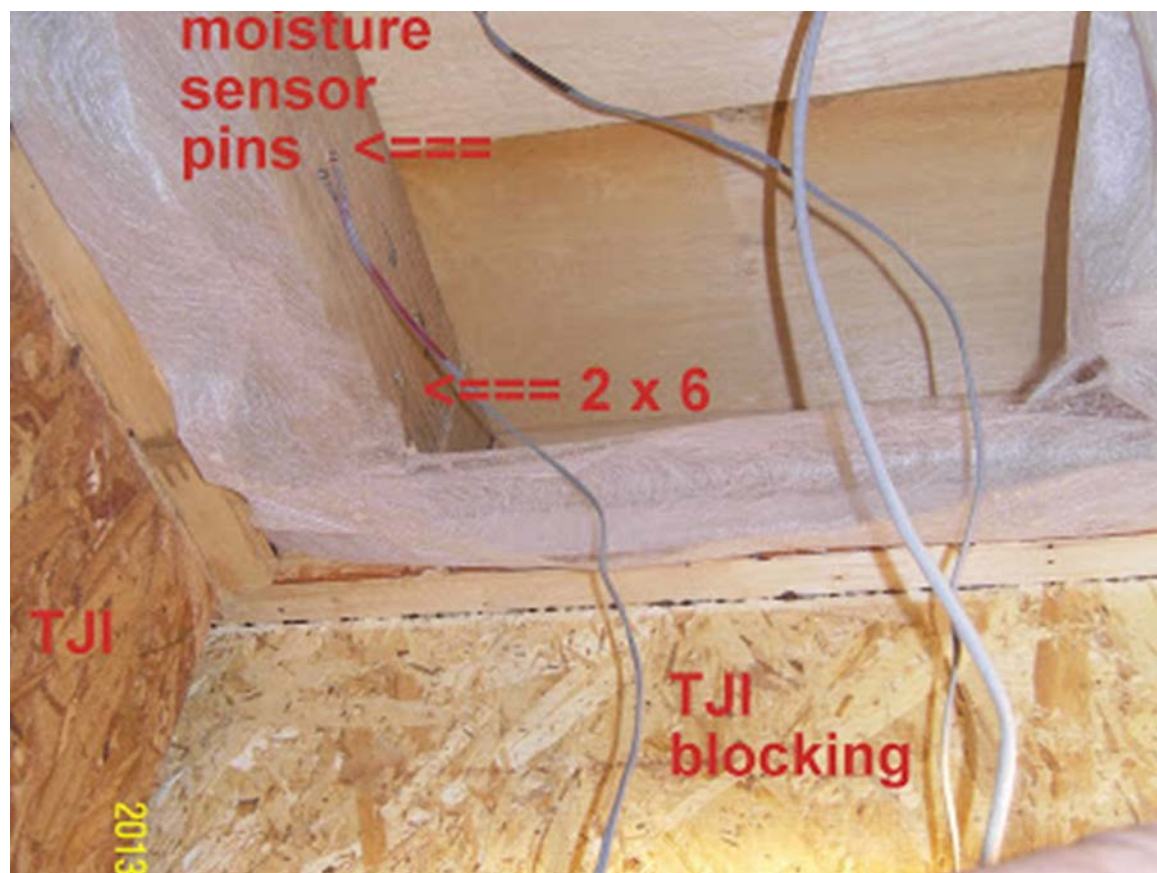


36" x 16" Roof Cavity



NE Roof Sensor, 60" up rake from North wall

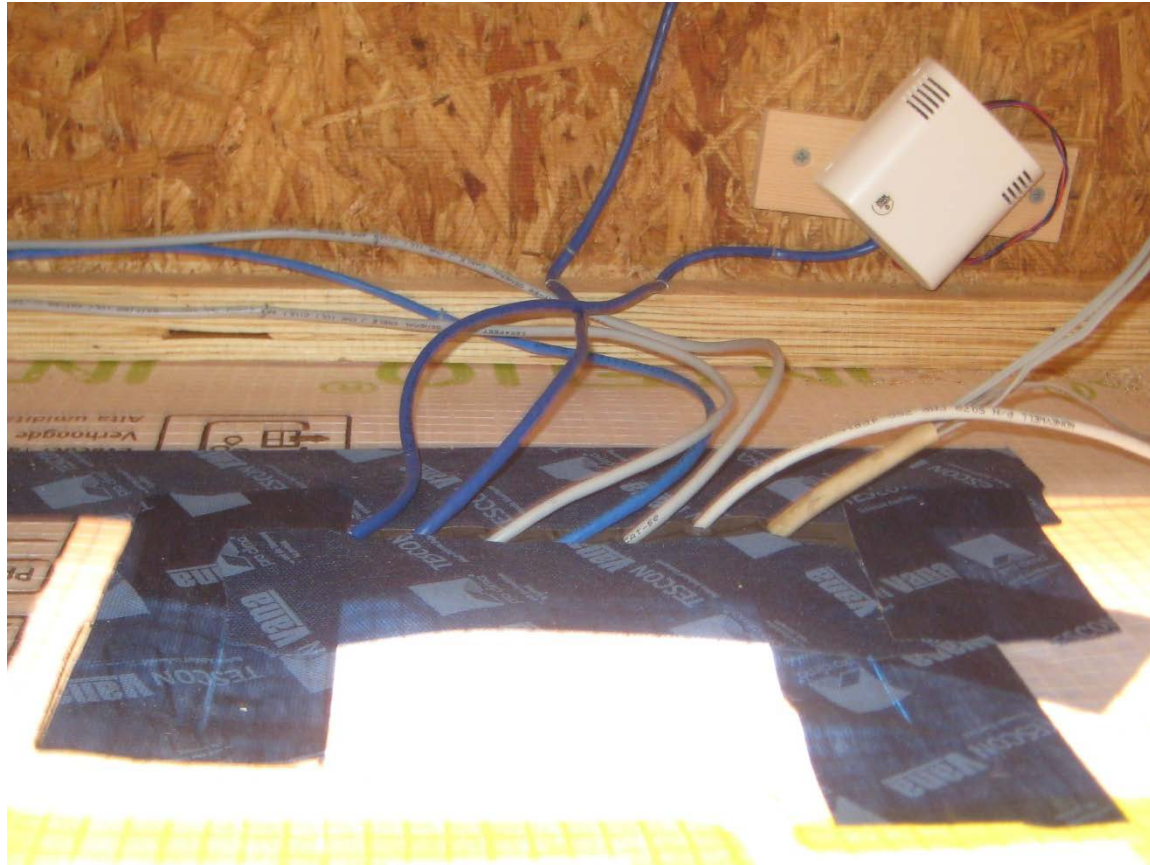




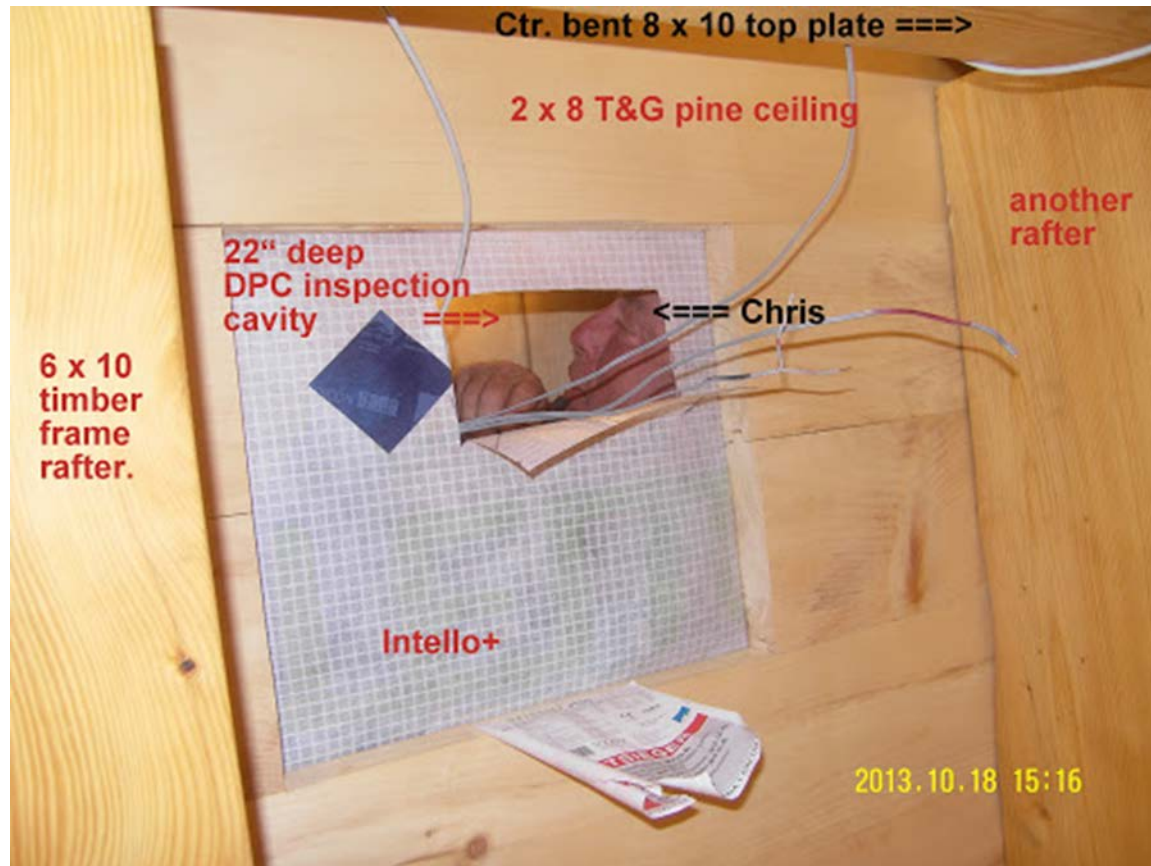


Center Roof

Outer Powerwise sensor and Moisture Meter probe extensions



Center Roof Inner Powerwise and wire gasket in ceiling



Center Roof





Center Roof Sensor Location



NE Roof Sensor Location

Powerwise cables run to Center Roof and Showing are Moisture Meter Extensions

