
BUILDING ENCLOSURE DESIGN: STRATEGIES FOR ACHIEVING PASSIVE HOUSE PERFORMANCE

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Disclaimer: This presentation was developed by a third party and is not funded by WoodWorks or the Softwood Lumber Board.
Passive House: Building Climate Action
Passive House: Building Climate Action
In Bella Bella: Same tenants on same site

Six-unit Passive House replaced six apartments built to former code
In Bella Bella: Same tenants on same site
The new building uses half the energy...

<table>
<thead>
<tr>
<th></th>
<th>Old Building</th>
<th>New Passive House</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total EUI</td>
<td>144</td>
<td>66</td>
</tr>
<tr>
<td>Propane EUI</td>
<td>38</td>
<td>0</td>
</tr>
<tr>
<td>Electricity EUI</td>
<td>106</td>
<td>66</td>
</tr>
</tbody>
</table>
...and emits one-tenth the carbon
What to we need to deliver?

Building as a System

- Control Heat
- Control Solar Gains
- Control Moisture
- Control Air
- Control Heat
MOVING TOWARDS SUSTAINABILITY
ALBERT, RIGHTEER & TITTMANN ARCHITECTS, INC.
Passive House: Delivery is in the Details

⇒ Rule #1: *Primum Non Nocere*

Do No Harm

Control Moisture
What do we know?

- Control Bulk Water
- Control Air
- Building Enclosure
- Control Vapor
- Control Heat
Control Functions & Critical Barriers

Water

Air

Heat

Vapor

Sound

Fire

Building Form & Features

Water Shedding Surface (WSS)

Water-Resistive Barrier (WRB)

Air Barrier System

Thermal Insulation

Vapor Retarder/Barrier

1 – Water is defined here as precipitation (rain, snow, hail, etc.) and ground water
2 – Vapor is separately defined here as the water vapor in air, as well as condensate moisture

Primary Relationship

Secondary Relationship
Massive Problems

Percent of walls that have moisture problems

Width of Overhang, mm

0 - 12" over 12"
Massive Problems
Building Science and Best Practices

- Building Form
  - Orientation
- Comprehensive management of
  - Heat
  - Air
  - Moisture
- Balanced Ventilation
- Right-Sized Mechanical Systems
Passive House Toolkit - PHIUS

WUFI - Passive
### Passive House verification

**Building:** Cascades Hudson  
**Street Address:** 3700 South Hudson Street  
**City, State, Zip:** Seattle, WA  
**Country:** USA  
**Building type:** Mixed-Use Apartments & Retail  
**Client:** Loo 2 - Boeing field  
**Owner:** 3700 Hudson LLC  
**Street Address:** 4111 E Madison St #104  
**City, State, Zip:** Seattle, WA 98112

#### Specific building demands with references to the treated floor area

<table>
<thead>
<tr>
<th>Treated floor area</th>
<th>Requirements</th>
<th>Fulfilled?</th>
</tr>
</thead>
<tbody>
<tr>
<td>14813 m²</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Space heating**

- Heating demand: 2.57 kBtu/ft²  
- Heating load: 3.43 kBtu/hr ft

**Space cooling**

- Overall specific space cooling demand: 0.97 kBtu/ft²  
- Cooling load: 1.65 kBtu/hr ft  
- Frequency of overheating (> 77°F): %

**Primary energy**

- 58.07 kBtu/ft²  
- DHV, space heating and auxiliary electricity: 12.7 kBtu/yr  
- Specific primary energy reduction through solar electricity: kBtu/yr

**Airtightness**

- Pressurization test result m³/h: 0.58 m³/h  
- %: 0.6 %  

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PHPP
This is the U factor for this whole blonic corner.
Massive Opportunities
Potential Opportunities

→ Enclosure to usable area ratio
→ Centralized mechanical systems
→ Building
  → Form
  → Details
→ Commercial systems
  → Envelope
  → Product delivery
  → Quality Control
→ Long-term value
Passive House Envelope Mantra

1. Super-Insulated
2. Air-Tight
3. Thermal Bridge Free
Passive House Envelope Mantra

1. **Super-Insulated**
2. **Air-Tight**
3. **Thermal Bridge Free**
1: Super-Insulated

super adjective

Definition of super: of high grade or quality
Just Enough

In **ALL** the right places
Starting Points: Effective R & U-Values

- >20,000ft²
- ‘Good Form’
- <35% Window to Wall Ratio

<table>
<thead>
<tr>
<th></th>
<th>Windows &amp; Doors</th>
<th>Floor</th>
<th>Wall</th>
<th>Roof</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mid-Atlantic</td>
<td>U-0.20 to 0.26</td>
<td>R-12 (slab)</td>
<td>R-24 to 30</td>
<td>R-40 to 60</td>
</tr>
<tr>
<td>North East</td>
<td>U-0.18 to 0.22</td>
<td>R-16 (slab)</td>
<td>R-28 to 32</td>
<td>R-50</td>
</tr>
<tr>
<td>Pacific NorthWest</td>
<td>U-0.18 to 0.24</td>
<td>R-12 (slab)</td>
<td>R-26 to 30</td>
<td>R-50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R-30 (suspended)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
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</tr>
</tbody>
</table>
Effective R-Value
Framing Factor Impact on Effective R-values

Effect of Wood Framing Factor on Effective R-value - 2x4 and 2x6 Walls

- Framing @ 16" o.c.
- Framing @ 24" o.c.
Common Walls in Massive Passive House
Continuous Insulation (c.i.) + Structural Frame
Continuous Insulation (c.i.) + Structural Frame

Orchards at Orenco - Phase II
Hillsboro, OR
Photos: Walsh Const.
Double-Stud Wall

Village Center Apts., Brewer, ME
Photos: Sandy Agrafiotis
Guide for Designing Energy-Efficient Building Enclosures for Wood-Frame Multi-Unit Residential Buildings in Marine to Cold Climate Zones in North America
2: Air -Tight
Why the Air Barrier is so important

Water \(^1\)  → Building Form & Features
Air
Heat
Vapor \(^2\)
Sound
Fire

Water Shedding Surface (WSS)
Water-Resistive Barrier (WRB)
Air Barrier System
Thermal Insulation
Vapor Retarder/Barrier

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Primary Relationship  Secondary Relationship

1 – Water is defined here as precipitation (rain, snow, hail, etc.) and ground water
2 – Vapor is separately defined here as the water vapor in air, as well as condensate moisture
Buildings are Becoming More Airtight

Airtightness versus Year of Construction

Sample of 179 Buildings

Airtightness [L/(s.m²) @ 75 Pa]
Airtightness [cfm/ft² @ 75 Pa]

Construction of Building [year]
But Passive House is a different level

Airtightness versus Year of Construction

Sample of 179 Buildings

Airtightness [L/(s.m²) @ 75 Pa]

Airtightness [cfm/ft² @ 75 Pa]

Construction of Building [year]
2: Air - Tight: Massive

How?

- Design
- QC & Testing
- Installation
Delivery is in the Details

Air Barrier Detail 2  Top of wall at Parapet

A-B across top of SIPN  Weather dependent:
* If Dry: SIGA Wigluv tape or approved substitute
* If Damp: Prosoco R-Guard

A-B at exterior seams of SIP with Approved Tape: Install prior to Roofing underlayment

Self-Adhering roofing underlayment

Continuous SIP to top of parapet (do not break at Roof Deck)

Ledger per SIP Manuf.

A-B at exterior seams of SIP with Approved Tape

Enclosed volume
Delivery is in the Details

Air Barrier Detail 8

See also A-B Detail 5

Step 1: A-B for panel edges on 8" of floor sheathing to 1" top face of Rim Contractor choice
*If Dry: SIGA Wiglulv tape or approved substitute
*If Damp: Prosoco R-Guard

**Note:** must install similar A-B at all panel edge locations below interior floor plates PRIOR to Wall installation

Step 2: A-B at exterior seams of SIP with Approved Tape

Step 3: A-B from SIP to Rim:
*If Dry: SIGA Wiglulv tape or approved substitute
*If Damp: Prosoco R-Guard

Step 4: A-B at all floor sheathing seams: SIGA Rissan
Which Material???
**** An Air Barrier is not a product but is a system of products installed over an array of materials ****
What materials have worked?

**Generally Air-tight**
- Structural Concrete
- Engineered Lumber
- Air Sealing Tapes
- Building Sealants
- Polyethylene sheet
- SASM

**Usually Air-Tight**
- Plywood
- OSB
- Sheet Membranes
- Fluid-Applied Barriers
What materials are subject to failure?

**May work**
- Unreinforced Concrete, esp flatwork
- Mechanically fastened membranes
- WRB Tapes
- Some roofing underlayment
- Spray foam (open and closed-cell)
- Standard Entry Doors

**Less Likely to work**
- Dimensional lumber
- CMU and masonry
- Drywall
- Emergency Egress Entry Doors
- Wishful thinking
- ????
**** An Air Barrier is not a product but is a system of products installed over an array of materials by a series of individuals ****
Sequencing is a part of detailing
An Air Barrier is not a product but is a system of products installed over an array of materials by a series of individuals and its integrity must be confirmed by a knowledgeable individual.
Preliminary Testing
-if you wait, you’re too late
ILLUSTRATED GUIDE

Achieving Airtight Buildings

This guide provides information for design and construction professionals to assist in designing, constructing, and testing airtight Part 3 and larger more complex Part 9 residential buildings in British Columbia.

BC HOUSING
BC Hydro
VANCOUVER
BRITISH COLUMBIA
1st test: 0.013 cfm/ft² @75Pa !!!
-In our immediate future: Mass Timber Passive House
The Future is Here: Tall Mass Wood Passive House
Site Installation – at Pace with Structure – 1 floors/day
LARGE PASSIVE HOUSE DEVELOPMENT: METRO DC

Hillandale

NK Architects and Torti Gallas Partnership
MASSIVE PASSIVE in the Pacific Northwest

ORCHARDS AT ORENCO Phase II
Hillsboro

REACH CDC
Ankron-Moison Architecture
Walsh CONstruction
MUNICIPAL PASSIVE HOUSE

FIRE HALL 17
Vancouver

City of Vancouver
HCMA Architecture
SKEENA DORM
Six stories, 220 rooms
UBC Okanagan

UBC Properties Trust
Public Architecture
THE HEIGHTS
85-unit market rental
Vancouver

8th Avenue Development
Cornerstone Architecture
Peak Construction Group
Solis
45-unit Market-Rate Condominiums
Seattle

Weber-Thompson Architects
Solterra Development
Cascade Built
CORVETTE LANDING
12 storeys, 83 units
Esquimalt

Standing Stone Development
LWPAC
1488 ALBERNI
48 storeys, 490 units
Vancouver

Landa Global
Asia Standard Americas
Robert A.M. Stern Architects
Musson Cattell Mackey
Passive House: Building Climate Action
- Don’t wait
Discussion + Questions

FOR FURTHER INFORMATION PLEASE VISIT
→ www.rdh.com
→ www.buildingsciencelabs.com

OR CONTACT US AT
→ dwhitmore@rdh.com