
BUILDING ENCLOSURE DESIGN: STRATEGIES FOR ACHIEVING PASSIVE HOUSE PERFORMANCE
FEBRUARY 5 & 6, 2019
PRESENTED BY DAN WHITMORE, CPHC

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
114,000 more people: Seattle now decade’s fastest-growing big city in all of U.S.

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Seattle moved into the top spot after registering yet another year of remarkable growth in 2017. The city’s population hit an estimated 725,000, gaining 17,500 people from July 1, 2016, to July 1, 2017. (Greg Gilbert / The Seattle Times)
“Here is one of the few effective keys to the Design problem: The ability of the Designer to recognise as many of the constraints as possible; his willingness and enthusiasm for working within these constraints.”

-Charles Eames
Keeping the Outside Out & the Inside In, Passively

Albert Righter & Tittmann Architects
Superior Interior Environmental Quality
Superior Energy Performance

<table>
<thead>
<tr>
<th></th>
<th>Old Building</th>
<th>New Passive House</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensity</td>
<td>9.6</td>
<td>0.7</td>
</tr>
</tbody>
</table>

**Carbon Intensity (kgCO$_2$e/m$^2$/year)**
What to we need to deliver?

- Keep the outside out
- Keep the inside in
- Keep the in-between healthy and stable

Building as a System
What to we need to deliver?

Building as a System

- Control Moisture
- Control Air
- Control Heat
- Control Solar Gains
MOVING TOWARDS SUSTAINABILITY
ALBERT, RIGITZER & TITTMANN ARCHITECTS, INC.
What is Passive House?

Engineering buildings to use ~ half the energy...
What is Passive House?
Building Science and Best Practices

- Building Form
  - Orientation
- Comprehensive management of
  - Heat
  - Air
  - Moisture
- Balanced Ventilation
- Right-Sized and Very Efficient Mechanical Systems

What is Passive House?
Building Form
Building Form

1:1 surface-floor ratio

Increase of 10%
Heat
Air
Moisture
Ventilation

- Ventilation
- Condensation
- Drain
- Exhaust
- Section
- Cold in
- Cold out
- Warm in
- Warm out
- 2'6" exhaust air
- 2'10" supply air
- Roof
- Level 6
- Level 5
- Zehnder ComfoAir 550
Efficient Mechanical Systems
What is Passive House?
Passive House Toolkit - PHIUS

WUFI - Passive
# Passive House Toolkit - PHI

## Passive House verification

### Building Information
- **Building:** Cascade Hudson
- **Street Address:** 3700 South Hudson Street
- **City, State, Zip:** Seattle, WA
- **Country:** USA
- **Building type:** Mixed-Use Apartments & Retail
- **Client:** 1st-2nd - Boeingfield
- **Owner:** 3700 Hudson LLC
- **Street Address:** 4111 E Madison St #104
- **City, State, Zip:** Seattle, WA 98112

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

<table>
<thead>
<tr>
<th>Demand</th>
<th>Treated Floor Area (m²)</th>
<th>Requirements</th>
<th>Fulfilled?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Space heating</strong></td>
<td></td>
<td>2.57 kBTU/(h² m²)</td>
<td>yes</td>
</tr>
<tr>
<td>Heating demand</td>
<td></td>
<td>50% of 1.50 kBTU/(h² m²)</td>
<td>yes</td>
</tr>
<tr>
<td>Heating load</td>
<td></td>
<td>3.43 BTU/(h² ft)</td>
<td>–</td>
</tr>
<tr>
<td><strong>Space cooling</strong></td>
<td></td>
<td>0.97 kBTU/(h² m²)</td>
<td>yes</td>
</tr>
<tr>
<td>Overall specific cooling</td>
<td></td>
<td>50% of 1.00 kBTU/(h² m²)</td>
<td>yes</td>
</tr>
<tr>
<td>Cooling load</td>
<td></td>
<td>1.65 BTU/(h² ft)</td>
<td>–</td>
</tr>
<tr>
<td>Frequency of overheating (&gt; 77 °F)</td>
<td></td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td><strong>Primary energy</strong></td>
<td></td>
<td>58.07 kBTU/(h² m²)</td>
<td>yes</td>
</tr>
<tr>
<td>Primary energy consumption</td>
<td></td>
<td>30% of 58.55 kBTU/(h² m²)</td>
<td>yes</td>
</tr>
<tr>
<td>DHW, space heating and auxiliary electricity</td>
<td></td>
<td>12.7 kBTU/(h² m²)</td>
<td>–</td>
</tr>
<tr>
<td>Specific primary energy reduction through solar electricity</td>
<td></td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td><strong>Airtightness</strong></td>
<td></td>
<td>0.58 l/s</td>
<td>–</td>
</tr>
<tr>
<td>Pressurization test result</td>
<td></td>
<td>0.5</td>
<td>–</td>
</tr>
</tbody>
</table>

*empty fields: data missing or not reported*
Passive House: Delivery is in the Details

Rule #1: *Primum Non Nocere*

Do No Harm

Control Moisture
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
Site Climate - Wetting Risk with Drying Potential
Massive Possibilities
Potential Possibilities

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

Photo: Chris Benedict, RA
Passive House Enclosure Mantra

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

Photo: Walsh Const.
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 0.24</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>
</tbody>
</table>
Effective R-Value
2: Air - Tight
Why the Air Barrier is so important

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
But Passive House is a different level

Airtightness versus Year of Construction

Sample of 179 Buildings
2: Air - Tight: Massive

- Design
- QC & Testing
- Installation

How?
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 Wiggly 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 Wiggly 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 underlayments
- Spray foam (open and closed-cell)
- Standard Entry Doors

Likely to fail

- 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.

Pax Futura Apartments
Photo: Vivian Usu
1st test: 0.013 cfm/ft² @75Pa !!!
3: Thermal-Bridge “Free”

→ Exterior Insulation Attachments

- Continuous...
- Continuous...
- Aluminum T-Clip
- Intermittent...
- Stainless Steel Clip
- Isolated...
- Fiberglass Clip Galv. Screws
- Galvanized Screws
- Fiberglass Clip SS Screws
- Stainless Steel Screws
- Fiberglass Clip No Through Screws
“If you must build something stupid, for God’s sake, build it with wood.”

~ Scott Kennedy
Cornerstone Architecture
And when it’s not of wood, be diligent
Continuous shelf angles
~50% R-value loss

Shelf angle on stand-offs
only ~15% R-value loss
Passive House Process

But how is this going to affect me?
- Passive House Process: ”But how is this going to effect my projects?”

<table>
<thead>
<tr>
<th>PROPOSED WINDOW MODIFICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original Window Layout</td>
</tr>
<tr>
<td><img src="image1.png" alt="Original Window Layout" /></td>
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</tbody>
</table>

Design and Development
Passive House Process:
“But how is this going to effect my projects?”

Design and Development
Passive House Process: ”But how is this going to effect my projects?”

1. Design Development
   Feasibility and Preliminary Studies
2. Design Stage Review
   Comprehensive review of a complete submission.
Passive House Process: “But how is this going to effect my projects?”

Delivery

Photos: Walsh Construction and RDH
- In our immediate future: Passive House and Oregon Energy Code

Executive Order No. 17-20
“...to establish an aggressive timeline to achieve net zero energy ready buildings as standard practice in buildings across the state.”
In our immediate future:
Passive House and Energy Code

RCW 19.27a.160
“.....residential and nonresidential construction permitted under the 2031 state energy code must achieve a seventy percent reduction in annual net energy consumption, using the adopted 2006 Washington state energy code as a baseline.”
-In our immediate future: Passive House and Energy Code

RCW 19.27a.160

“…..residential and nonresidential construction permitted under the 2031 state energy code must achieve a seventy percent reduction in annual net energy consumption, using the adopted 2006 Washington state energy code as a baseline.”
MASSIVE PASSIVE in the Pacific Northwest

ORCHARDS AT ORENCO Phase II
Hillsboro

REACH CDC
Ankron-Moison Architecture
Walsh CONstruction
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
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