AIR BARRIER
Approaches for Large Passive Buildings

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What is the **AIR BARRIER**?

**Air Barrier**
Material(s) assembled and joined together to provide a barrier to air leakage through the building envelope. An air barrier may be a single material or a combination of materials.

**Continuous Air Barrier**
A combination of materials and assemblies that restrict or prevent the passage of air through the building thermal envelope.
Air barriers are **SYSTEMS** not products.
Why is it so important?

Water ¹
Air
Heat
Vapor ²
Sound
Fire

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

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
Who is installing?  
And **WHEN?**
Current Standards

1.80 cfm @ 75 Pa / ft² - ASHRAE baseline for buildings with no air barrier

0.40 cfm @ 75 Pa / ft² - Air Barrier Association of America

0.25 cfm @ 75 Pa / ft² - U.S. Corp of Engineers / GSA

0.08 cfm @ 75 Pa / ft² - Passive House 6+ stories 0.05 cfm/ft² others

0.0 @ 50 Pa - Passive House Institute International
Driving Forces

Air leakage is the combination of airtightness and pressure differences

Stack Effect + Wind + Mechanical Systems = Cumulative
Stack effect is influenced by CLIMATE.

40m (130 ft) tall building in Yellowknife

Percentage of Driving Force Pressure

- Wind
- Stack Effect
- Mechanical
Driving forces vary by REGION.

Stack effect is dominant in colder climates.
Peanut Butter – 20 mils = 0.00041 cfm/ft

More than twice as tight as Tyvek
CONTINUITY over impermeability
Compatibility (the stuff needs to STICK!)
Changes in **SELECTION**

Shifts from *mechanically attached* to *self-adhesive* and *liquid-applied* membranes
Sheathing Membrane
Sealed Sheathing
Liquid-Applied Membrane
Interior: Panelized Systems
Cornell Passive House

Handel Architects

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Cornell Passive House
Many systems. Details matter.

- Loose sheet applied membrane – taped joints & strapping
- Sealed gypsum sheathing – sealant filler at joints
- Liquid applied sealants/membranes
- Mass walls (concrete)
- Self-adhered vapor permeable membrane
- Self-adhered vapor impermeable membrane
- Spray foam
- Curtainwall, window-wall & glazing systems

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Air Barrier Detailing

Non-combustible
- Parapet
- Service penetration
- Floor slab
- Window wall
- Storefront/curtain wall

Wood-frame
- Top of wall at low slope roof
- Punch window
- Deck
- Balcony
- Base of wall at foundation
- Foundation wall at slab
Air Barrier Detailing

- Highlight air barrier in all sections and details
- Identify every material and require change and compatibility review for any material change
- Clearly identify transitions between materials and review compatibility
- Coordinate spec to plans
- Consider an “Air Barrier” section
Air Barrier Design
Manufacturer Details

Parapet
Form-A-Barrier Liquid Air Barrier System

Important Notes:
A. Detail not suitable for all climates. Avoiding moisture conditions occurring in exterior walk is essential as severe ionization of moisture could result in water damage with resultant wall designs. Refer to ventilation systems of ventilation and moisture control for moisture levels. Refer to installation instructions of ventilation and moisture control for moisture levels. Refer to installation instructions of ventilation and moisture control for moisture levels.
B. Ensure window system is properly aligned with wall insulation and headlamps per the window manufacturer’s recommendations to ensure continuity of the air barrier system.
C. Install all Gypsum Technologies product to be consistent with Gypsum Technologies Product Data Sheets and Gypsum Technologies recommendations.

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WINDOW A' DETAILS
AB-H113

Henry Company
Design-Build Details

Walsh Construction

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Tricky Transitions

- Pay attention to “interior” walls
- Conditioned space in garages
- Fire details not always airtight
Transitions + Air Leaks

If leakage areas were identified, what were the most common problem areas?

- Roof to wall transitions: 45%
- Base of wall or floor line transitions: 10%
- Mechanical penetrations: 40%
- Dampers: 35%
- Soffits: 5%
- Vented roof assemblies: 15%
Common Deficiencies

- Structural and service wall penetrations
- Wrinkled, fish-mouth, incomplete membrane laps
- Roof-to-wall and where transition materials are used
- Roof/ceiling penetrations
- Window membrane and perimeter sealing
- Interior ceiling penetrations and partition walls
- Above-grade to below-grade transitions
Specifications. Keep it SIMPLE.

- **Compatibility:** Letter from manufacturer
- **Pre-Construction Meeting:** 2-4 weeks prior to work
- **Performance Requirements:** Air and vapor permeance, accessories
- **Substrate Preparation:** Bonded vs. fastened
- **Installation:** Manufacturer instructions
- **Quality Requirements:** Submittals, mock-ups, quality control
The Air Sealing Specialist

- Knows every air barrier detail
- Provides regular group briefings and 1-on-1 guidance for trades
- Inspects all components daily
- Documents all penetrations and interfaces
- Coordinates with enclosure and PH consultants
- Coordinates and assists airtightness testing
- Oversees all repairs
Pre-Construction Meetings

• Essential for successful execution
• Should be in the specifications
• Coordination of trades / resolution of questions
• Consider Air-Tightness Coordinator
Mock-ups

- Critical to confirm sequencing
- Allows for verification and final adjustments of transitions and details
- Not only for the air barrier
Air Tightness Test

Orchards of Orenco Phase 1

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Mock-ups

- Ensure mechanical and other intentional openings are covered during the test
- Leaky dampers can increase leakage by 40-70%

How do you get here to seal these?
Test **EARLY.**

- Test as early as possible.
- Air barrier needs to be complete (sequencing can be difficult)
- Easier test prep if duct work isn’t finished
- Better test results
- Better opportunity for remedial work
Protocols + Results

- ASTM E779
- USACE
- SEC (pressurize only)
- RESNET (PHIUS)
- EN13829 (PHI)
- CGSB 149.10 (CAN)

### Building Leakage Test Details

**Date of Test:** 6/13/2012  
**Test File:** 2nd Test - Semi Auto  
**Customer:** Green Hammer  
**Building Address:** Cash House 1503 NE More St  
**Phone:**  
**Fax:**  
**Technician:** Ryan Shanahan

#### Test Results at 50 Pascals

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Depressurization</th>
<th>Pressurization</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>V50 (cfm Airflow)</td>
<td>48 (± 23 %)</td>
<td>67 (± 27 %)</td>
<td>56</td>
</tr>
<tr>
<td>n50 (1/h Air Change Rate)</td>
<td>0.23</td>
<td>0.33</td>
<td>0.28</td>
</tr>
<tr>
<td>W50 (cfm²/Floor Area)</td>
<td>0.0307</td>
<td>0.0322</td>
<td>0.0314</td>
</tr>
<tr>
<td>LBL ELA @ 4 Pa (in²)</td>
<td>3.6 (± 14.2 %)</td>
<td>7.5 (± 2.4 %)</td>
<td>5.5</td>
</tr>
<tr>
<td>LBL ELA @ 4 Pa (surface)</td>
<td>0.0008</td>
<td>0.0014</td>
<td>0.0012</td>
</tr>
<tr>
<td>Building Leakage Curve: Air Flow Coefficient (Cenv) (cfm/Pa⁻ⁿ)</td>
<td>1.8 (± 34.6 %)</td>
<td>6.3 (± 5.9 %)</td>
<td></td>
</tr>
<tr>
<td>Exponent (n)</td>
<td>0.844 (± 0.090)</td>
<td>0.608 (± 0.016)</td>
<td></td>
</tr>
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</table>

#### Test Standard
- EN 13829

#### Test Mode
- Depressurization and Pressurization
- Type of Test Method: A
- Regulation complied with: Passive House: n50 ≤ 0.6 1/h
Status: The Numbers

Airtightness vs Year of Construction

Sample of 179 Buildings

Construction of Building [year]

Airtightness [L/(s·m²) @ 75 Pa]

Airtightness [cfm/ft² @ 75 Pa]
Performance

![Graph showing airtightness for different building approaches.]

- **WA State Requirement**
- **Median**
- **PHI q50 recommendation**
- **Leakiest Tested**
- **Tightest Tested**

**Airtightness**
- **[L/(s·m²) @ 75 Pa]**
- **[cfm/ft² @ 75 Pa]**

**Approaches for Large Buildings**
- Liquid Applied (10 Buildings)
- Sealed Sheathing (11 Buildings)
- Sheet Applied (28 Buildings)
- Curtain Wall/Window Wall/Storefront (15 Buildings)

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Take-Aways

• Air Barriers are required by code
• Carefully select performance requirements
• Ensure the air barrier is continuous through all building sections
• Pre-Construction meetings and mock-ups are critical
• Plan quality control (dedicated on-site coordinator)
• Conduct whole building air-tightness tests
Thank You!