All attendees have been placed on mute.

Q&A will take place at the end of each segment.

Webinar will be recorded and sent.

Use the Question Section on the webinar control panel to ask a question at anytime during the presentation.

Submit Responses via PollEverywhere

- Respond at PollEV.com/swa335
- Or text swa335 at 22333 to join, then send your answer
The Sponsors of Energize Connecticut, and in partnership with Connecticut Passive House, are pleased to offer Passive House Initiative to support workforce development and help transform the energy efficiency and building construction industries in Connecticut.

For more information, please visit EnergizeCT.com/passive-house or email PassiveHouseTrainingCT@icf.com
Take energy efficiency to a new level

Residential New Construction Passive House Multi-family buildings with five units or more
# Passive House Incentive Structure for Multi-Family (5 Units or More)

<table>
<thead>
<tr>
<th>Incentive Timing</th>
<th>Activity</th>
<th>Incentive Amount</th>
<th>Max Incentive (Per Unit)</th>
<th>Max Incentive (Per Project)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Construction</td>
<td>Feasibility Study¹</td>
<td>Up to 100% of Feasibility Study Costs</td>
<td>N/A</td>
<td>$5,000.00</td>
</tr>
<tr>
<td></td>
<td>Energy Modeling²</td>
<td>75% of Energy Modeling Costs (Before 90% Design Drawings)</td>
<td>$500.00</td>
<td>$30,000.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50% of Energy Modeling Costs (90% Design/50% Construction)</td>
<td>$250.00</td>
<td>$15,000.00</td>
</tr>
<tr>
<td>Post Construction</td>
<td>Certification³</td>
<td>Up to 100% of Certification Costs</td>
<td>$1,500.00</td>
<td>$60,000.00</td>
</tr>
</tbody>
</table>

1. Feasibility Study will require documentation in the form of a Feasibility Study report and invoice from the Passive House Consultant.
2. Incentives will only be awarded prior to 50% Construction Drawings for Passive House projects. No incentives will be granted after 50% Construction Drawing set.
3. Certification may be either through PHIUS, PHI, or EnerPHit certification offerings.

---

Next steps you can take...
Contact your Energy Efficiency Representative or

Go to [EnergizeCT.com](http://EnergizeCT.com) or call 1-877-WISE USE for more details.

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Workshop 2, Part 1
Air Sealing and
Insulation for Homes
Since 1972, Steven Winter Associates, Inc. has been providing research, consulting, and advisory services to improve the built environment for private and public sector clients.

Our services include:

- Energy Conservation and Management
- Decarbonization
- Sustainability Consulting
- Green Building Certification
- Accessibility Consulting

Our teams are based across four office locations:
New York, NY | Washington, DC | Norwalk, CT | Boston, MA

For more information, visit www.swinter.com
Learning Objectives

Summarize typical materials and methods for air barriers on high performance projects

Identify challenging details and propose solutions to overcome

Describe common approaches for air barriers on residential projects

Recognize alternative strategies for air barrier implementation
Overview of Presentation

1. High Performance Basics
2. Review various types of air barrier products and proper installation
3. Identify challenging details and look at solutions

5 min break ~2:50 PM

Wrap Up ~4:00 PM
What is your profession?

A. Architect
B. Engineer
C. Contractor/CM
D. Owner/Developer
E. Consultant
F. Other
What is the one thing that you were hoping to learn about today? (hint: link words with an underscore)
Why are We Here

• Push for Building Electrification (Passive House as a pathway)
• Incentives available
• Benefits
  • Drastically lower energy use and operational cost savings
  • Healthy air quality from ventilation systems
  • Consistent and comfortable room temperatures without air drafts
  • Increased natural lighting and quieter acoustic conditions
  • A more resilient and comfortable building
These Trainings - Each has two parts

- **Workshop 1:** Continuous Insulation
- **Workshop 2:** Air Sealing and Insulation for Homes
- **Workshop 3:** High Performance Ventilation Systems for Homes
High Performance Basics
Goals of High Performance Buildings

- Building durability
- Energy $ reduction
- Optimal thermal comfort
- Superior indoor air quality
- Carbon emissions reductions
Passive House as a Pathway to High Performance

- Thermal insulation continuity
- Thermal bridge free construction
- Solar control
- Airtightness
- Balanced mechanical ventilation
Continuous Insulation
• Basic Components
  • Gauge (manometer)
  • Shroud
  • Frame
  • Fan
**Balanced Ventilation and Heat/Energy Recovery**

- Provide fresh, filtered air 24 hours a day
- Heat exchanger +75% Efficient
- Highly insulated and air-sealed ductwork
Questions?
Air Barrier Options
# Building Enclosure Attributes

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal Insulation</td>
<td>Slows the transfer of thermal energy (heat)</td>
</tr>
<tr>
<td><strong>Air Barrier</strong></td>
<td>Slows the movement of air through an assembly</td>
</tr>
<tr>
<td>Water Resistive Barrier</td>
<td>Part of the assembly that protects the enclosure from water penetration</td>
</tr>
<tr>
<td>Drainage Plane</td>
<td>Provides a predictable path for shedding water</td>
</tr>
<tr>
<td>Vapor Retarder</td>
<td>Slows the rate of vapor diffusion</td>
</tr>
</tbody>
</table>

**Continuous air barrier**: the combination of interconnected materials, assemblies, and sealed joints and components of the building envelope that minimize air leakage into or out of the building envelope. *The System.*
Air Barriers

- 90% of moisture transport is by air movement, not diffusion through materials.
- Insulation is ineffective without air sealing.
- Leakage occurs primarily at edges, corners, joints, penetrations, transitions, and terminations.
Air Barrier Strategies

- Mechanically attached sheet
- Sheathing with integrated WRB and air barrier
- Self adhered sheet membrane
- Fluid applied membrane
- Closed cell spray foam*
- Board stock (e.g. Thermax system)
- AerobARRIER
- Others (ProClima, Siga, etc.)

Credit: Building Science Corp
What is the most common air barrier type seen on your projects? (hint: link words with an underscore)
Mechanically Attached Sheet

- Common on ‘typical’ projects
- Held in place with staples / cap nails
- *Could* be used as an air barrier, but pretty rare:
  - All seams must be sealed
  - Top and bottom edges must be sealed
  - Edges at rough openings must be sealed
  - Siding contractors can’t cut it to get it to lie flat
  - Tears, rips, cuts all need to be fully patched

Credit: Green Building Advisor
https://www.energyvanguard.com/blog/5-reasons-house-wrap-is-not-an-air-barrier/
Sheathing w/ Integrated Air Barrier

- Continuous air barrier is applied in the factory on the face of the board
- Panel joints are sealed on site either with tape or liquid flashing

Credit: Zip System, ArmorWall
Self Adhered Sheet Membrane

- Consistent thickness ensures proper air barrier coverage
- Substrate needs to be free from debris and flat to ensure proper adhesion
- Often, must be used with a primer along with other accessories from the same manufacturer
- Needs to be rolled flat to avoid wrinkles and fishmouths
Fluid Applied Membrane

- Rolled / painted / sprayed onto the wall substrate
- Need to follow manufacturer directions for thickness
- Can be easier to use around tricky geometry vs. the origami of sheet membranes

Credit: Hammer & Hand
Closed-Cell Spray Foam (ccSPF)

- Can be controversial as an air barrier
- Minimum 1 inch to be considered air barrier per ASHRAE 90.1
- Chemical mixtures need to be accurate for proper application
- Potential concerns about shrinkage*
- Provides air sealing and insulation in one product

Board Stock Air Barrier

• Heavy duty polyiso insulation with all seams sealed

Credit: DuPont
AeroBarrier - Mist Applied

- Pressurizes the space and blows in aerosolized sealant
- Best for sealing smaller holes, up to ½” size
- Best for sealing very difficult to reach areas
- Prep work is required (windows, cabinets, etc. to be protected)
- Run with computer software; gives a report at the end showing the reduction in leakage and the final leakage result
Other Options

Pro Clima interior air barrier

Siga interior air barrier
Thermal and Air Barrier Boundary

• What is the primary air barrier?
• Is it on the outside? Inside? Some combination of both?
• How does it interface with components such as windows and doors?
• Does it pass the red line test?
Red Line Test – Air Barrier Continuity

- Be able to draw a continuous red line around the entire building perimeter indicating the air sealed surface
- Both in plan and section views
- Circle all transitions points, corners, changes in components, cantilevers, wall/roof, slab wall, etc.
- Provide details for how all these will be air sealed.
Red Line Test – Air Barrier Continuity

STOREFRONT DOOR TO BE PROVIDED WITH WEATHER STRIPPED.
USE HENRY SA BLUE SKIN ON VERTICAL OPENINGS
AND HENRY PAW FOR HORIZONTAL OPENINGS
(HEAD/SILL)

HM DOOR W/ WEATHER STRIPPING.
USE STO GOLD COAT ON VERTICAL OPENINGS AND
STO GOLD COAT FOR HORIZONTAL OPENINGS
(HEAD/SILL)

WINDOW IN PUNCHED OPENING.
USE STO GOLD COAT ON VERTICAL OPENINGS
AND STO GOLD COAT FOR HORIZONTAL OPENINGS
(HEAD/SILL)

EIFS WITH CMU WALL.
USE STO GOLD COAT.

AIR BARRIER AT EXTERIOR WALLS

AIR BARRIERS—AIRTIGHT DRYWALL APPROACH DETAILS

APARTMENT ENTRY DOOR TO BE WEATHER STRIPPED AND SEALED

TYPICAL FLOOR PLAN (2ND - 6TH) AIR BARRIER DIAGRAM

3/32" = 1'-0"
Air Barrier Boundary

When should planning for the air barrier strategy on a project begin?

A. As early as possible / schematic design

B. When the builder asks about it

C. Once all the materials arrive at the project site

D. No planning needed – just run the blower door test at the end!
Air Barrier Quality Assurance

- aka Get all the details and information into the drawings and specifications, early!

<table>
<thead>
<tr>
<th>QA</th>
<th>QC</th>
</tr>
</thead>
<tbody>
<tr>
<td>A management tool</td>
<td>A corrective tool</td>
</tr>
<tr>
<td>Process-oriented</td>
<td>Product-oriented</td>
</tr>
<tr>
<td>Proactive strategy</td>
<td>Reactive strategy</td>
</tr>
<tr>
<td>Prevention of defects</td>
<td>Detection of defects</td>
</tr>
<tr>
<td>Everyone’ responsibility</td>
<td>Testing &amp; verifications team’s responsibility</td>
</tr>
<tr>
<td>Planned then performed in parallel with a project</td>
<td>Preformed after final product is ready</td>
</tr>
</tbody>
</table>
Planning Timelines

Pre-Design
- DEFINE CONSTRAINTS
  - Urbanization
  - Adaptation
  - Mitigation
- Define Balance
  - Passive House?
  - Net Zero?
  - Combo?
- Hire CPHC or equivalent
- Massing PHPP or Design PH

Schematic Design
- ENERGY MODEL WORKSHOP
  - Glazing
  - Opaque
  - Thermal Bridges
  - Ventilation
  - DHW
  - Cooling & Heat
  - Primary Energy
  - Draw key details
  - Choose BOD mech
  - 90% SD: First package to certifier

Design Development
- DETAIL EARLY AND OFTEN
  - Respond to guidance from bldg certifier
  - Checklist of enclosure & mech details required
  - Start w/big things
  - 50% DD
  - Review checklist
  - Detail again
  - 90% DD: Second package to certifier

Construction Documents
- THIRD-PARTY REVIEW B4 IFC
  - Respond to guidance from bldg certifier
  - 50% CD
  - All drawings
  - All THERMS
  - All mech cals
  - PER cals
  - 90% DD: Final pre-construction package to certifier (DSR Submission)

Construction Activities
- QA/QC PLAN
- Passive House Verification Plan
  - Training
  - Site Visits
  - Air Testing
  - Ventilation Commissioning
  - Respond to PER request
  - Review site visit reports (SVRs)
  - Compile photographs & documents
Air Barrier Quality Assurance

• Focus especially on tricky areas and ensure clear details are provided
• The straight field of wall is the easiest; really need to dig into the more challenging details and clearly show them.
Air Barrier QA/QC

• To measure construction quality both QA and QC are essential to ensure the project is executed according to the standards

• It is critical to define quality with the owner
  • If Passive House certification or net zero is required by the owner a baseline of acceptable quality for high performance is required

• Factors include schedule, budget, fulfillment of specifications, ensuring final product preforms the intended purpose

• Contractor training is essential for proper execution
Air Barrier Implementation

• Achieving whole **building air tightness** is an overall goal that impacts **many trades**, which need to be coordinated
  • Foundation waterproofing contractor
  • Above grade air barrier / waterproofing contractor
  • Roofing contractor
  • Window contractor
  • Storefront / entry doors
  • Carpenter
  • Spray foam installer (if applicable)
  • MEP trades, since it’s assumed they will need to penetrate the exterior air barrier at some point to run various services
What are some problems that you have seen during air barrier installation? (hint: link words with an underscore)
Factors Impacting Air Barrier Performance

• Wrong or incompatible materials
• Missing materials – e.g. not using primer or sealant from the air barrier manufacturer when it’s needed
• Installers who don’t know how to properly install the product
• UV exposure beyond what the manufacturer calls for
• Not fully adhered / not sticking / peeling away from the wall
• Missing or incomplete coverage
Good Photos – ZIP
Bad Photos – Zip

- Roll the tape!!!
Bad Photos – ZIP

Tape needs a backing surface to stay fully adhered.

Tape is damaged, incomplete, and not fully adhered

Excessive nail holes & misses; ensure all will get taped over.
Near impossible geometry & no sealing plan at porch overhand

Fishmouth – both water and air infiltration point

Wiring penetrations – how will these get sealed?
Evidence of primer being used, sheets are flat against the wall, and a roller was used during the install
Bad Photos – Sheet Membrane

Membrane not fully adhered, fishmouths

Membrane not anywhere near fully adhered

Bunching and wrinkles at the roof line, and missing in the corner
Membrane tears and damage at an outside corner

Several overlaps, held in place with staples & not fully adhered. Should be a continuous piece at corners.
A Tale of Two Air Barriers

• Exterior air barrier vs. compartmentalization air barrier
  • If needed for ENERGY STAR, PHIUS, LEED, etc.

• Compartmentalization benefits
  • Reduce odors, sounds, fire transmission between units
  • Ventilation system works better with tighter units

• There are overlaps with firestopping in many cases, but don’t rely on the fire inspector solely for those inspections

• Townhouse style homes can be particularly tricky with shared fire walls & breakaway clips
Compartmentalization Testing

Compartmentalization testing
Single blower door and operator
Compartmentalization Guides

Air Sealing Guides

- Air Sealing for Multifamily Masonry Construction
- Air Sealing for Multifamily Steel Construction
- Air Sealing Guide for Multifamily Wood Construction

Compartmentalization - Key Areas
Compartmentalization - Key Areas

**Diagram 5: Demising / Interior Wall at Exterior / Corridor Wall**

**Notes:**
A. Intent: reduce leakage between exterior / corridor wall and demising wall / interior partition
B. Option: sheathing (at shear walls)
C. Similar at double walls

**Responsibilities:**
- Framing: A
- Drywall: B
- Mech/Elec/Plumb: C

**Diagram 6: Alternate - Demising / Interior Wall at Exterior / Corridor Wall**

**Notes:**
A. Intent: reduce leakage between exterior / corridor wall and demising wall / interior partition
B. Option: apply drywall adhesive to framing BEFORE installing drywall

**Responsibilities:**
- Drywall: B
- Mech/Elec/Plumb: A
Compartmentalization - Key Areas
Compartmentalization - Key Areas

- Electrical box at demising walls sealed
- Sealed Kitchen sink penetration with spray foam/caulk
- Unsealed door frame, needs caulking around entire perimeter
Questions?
5 Minute Break
Wood Framed – Red Line Test
Wood Framed – Below Grade to Above

- Flexible through wall flashings (if necessary) membrane, flash under vertical WRS W compatible tape & flashing.
- Wall anchor bolt: refer to structural drawing.
- Cell duct block to underside of plate prior to setting basis of design conservation technologies.
- Drywall gasket, seal drywall to cold plate basis of design conservation technologies.
- Flashing under WRS W compatible tape & flashing sleeve extra under slab vapor barrier before pouring the concrete slab on grade to allow connection to the vertical WRS.

- Provide 1" rigid insulation (R-5.5) at slab edge taper slab edge insulation to exterior wall, refer to detail.
- Provide 2" rigid insulation (R-19) below slab; provide 2" min rigid insulation (R-12) min down to footing, both sides of foundation wall.
Wood Framed – Above Grade Walls
What challenges have you seen with Zip taping or liquid flash installation? (hint: link words with an underscore)
Wood Framed – Window to Main Air Barrier
Wood Framed – Window to Main Air Barrier
Wood Framed – Band Joist

BAND JOIST DETAIL @ SIDING
Wood Framed – ERV Vents
Wood Framed – Porches, Balconies
Wood Framed – Attic Hatch (Attic Slope vs. Floor)
Wood Framed – Above Grade to Roof
Wood Framed – Above Grade to Roof
Wood Framed – Flat Roof
Wood Framed – Sloped Roof Mansard
Wood Framed – Wall to Roof

- EPDM Roof System
- Rigid Insulation (R-42) atop roof sheathing
- Roof sheathing with integral WRB, tape all seams, corners and junctions per manufacturer specifications
- 2x roof joist refer to struct. dwgs
- Joist hanger on 2x ledger boards refer to struct. dwgs.
- CANT
- Quick applied cured coverstrip at conjunction w/ EPDM primer
- Aluminum coping
- Metal cleat drip edge
- Vinyl J-bead trim
- Vinyl lap siding
- Open cell spray foam insulation. Completely fill cavity @ joist covering all framing and maintain R-21 min. insulation to extend at least 4" inward.
- 2 layers type X gyp. ceiling board
- Insulated sheathing w/ integral WRB, tape all seams, corners and junctions per manufacturer specifications
- To Parapet 38'-8"
Wood Framed – Wall to Roof Sequencing
On the construction site, who should take responsibility for keeping an eye on the air barrier system installation? (hint: link words with an underscore)
Mock-ups are critical to see firsthand the project specific details.
Wood Framed – Air Barrier vs Insulation Install Sequencing
Spray Foam – Relying on it as an Air Barrier

- Spray foam is not a bulletproof approach to air sealing
- Installer may not be able to get the nozzle into tight areas and maintain the continuous air barrier
- Thorough review needed of the installation before it becomes inaccessible
Wood Framed – Spray Foam
During final whole building blower door IR images show air leakage where spray foam is missed.
During final whole building blower door IR images show air leakage where spray foam is missed.
What are your final thoughts and takeaways from the presentation today? (hint: link words with an underscore)
Questions & Final Discussion
Join Us for More Trainings!

- **Workshop 1**: Continuous Insulation
- **Workshop 2**: Air Sealing and Insulation for Homes
- **Workshop 3**: High Performance Ventilation Systems for Homes
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Thank You

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