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#### 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)				
Incentive Timing	Activity	Incentive Amount	Max Incentive (Per Unit)	Max Incentive (Per Project)
Pre-Construction	Feasibility Study <sup>1</sup>	Up to 100% of Feasibility Study Costs	N/A	\$5,000.00
	Energy Modeling <sup>2</sup>	75% of Energy Modeling Costs (Before 90% Design Drawings)	\$500.00	\$30,000.00
		50% of Energy Modeling Costs (90% Design/50% Construction)	\$250.00	\$15,000.00
Post Construction	Certification <sup>3</sup>	Up to 100% of Certification Costs	\$1,500.00	\$60,000.00

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.

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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



#### By providing a whole-building approach to design, construction, and operation

### 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





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#### 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)

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- 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

www.surehouse.org



#### **Continuous** Insulation











#### Air-Tightness Blower Door Testing



#### **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





**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



Credit: Building Science Corp



- 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.)

What is the most common air barrier type seen on your projects? (hint: link words with an underscore)

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#### Mechanically Attached Sheet



Credit: Green Building Advisor

https://www.energyvanguard.com/blog/5-reasons-house-wrap-is-not-an-air-barrier/



- 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

#### 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 <sup>1</sup>/<sub>2</sub>" 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





#### **Red** Line Test – Air Barrier Continuity




## **Red** Line Test – Compartmentalization









## Air Barrier Boundary





https://www.owenscorning.com/en-us/insulation/residential

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

A. As early a 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!

QA	QC
A management tool	A corrective tool
Process-oriented	Product-oriented
Proactive strategy	Reactive strategy
Prevention of defects	Detection of defects
Everyone' responsibility	Testing & verifications team's responsibility
Planned then performed in parallel with a project	Preformed after final product is ready

## **Planning** Timelines





## 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.

#### Bad Photos – ZIP





Near impossible geometry & no sealing plan at porch overhand



Fishmouth – both water and air infiltration point



Wiring penetrations – how will these get sealed?

## Good Photos – Sheet Membrane







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

## **Bad** Photos – Sheet Membrane





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 Guides**





https://www.swinter.com/about-us/news/news-item/air-sealing-guides/



















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







## **Wood** Framed – Above Grade Walls







What challenges have you seen with Zip taping or liquid flash installation? (hint: link words with an underscore)

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## Wood Framed – Window to Main Air Barrier







## Wood Framed – Window to Main Air Barrier







## Wood Framed – Band Joist







#### 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





#### Wood Framed – Wall to Roof Sequencing





Image Credit: Risinger Build

# On the construction site, who should take responsibility for keeping an eye on the air barrier system installation? (hint: link words with an underscore)

#### Wood Framed – Getting the Details Right







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







#### Wood Framed – Spray Foam





During final whole building blower door IR images show air leakage where spray foam is missed.

#### Wood Framed – Spray Foam





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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