

Approaches to Efficient Envelope Design

Air Barrier for High-Performance Buildings

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Why Airtight

Comfort

Better control over indoor environment

Health

Prevents infiltration of pollutants

Energy

Uncontrolled air flow can account for 15-25% of energy loss

Durability

Prevents accumulation of moisture and building enclosure issues

What is the Air Barrier?

2014 OEESC:

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.

Control Layers

Water Control Layer

Controls the passage of liquid water. Typically the drainage plane behind the exterior façade.

Air Control Layer

Materials or assemblies controlling air flow from conditioned to unconditioned space.

Thermal Control Layer

Components installed to control the transfer of thermal energy or heat.

Vapor Control Layer

Controls the movement of water vapor through diffusion.

Code Requirements

2014 OEEESC 502.4.1.2 Air Barrier Compliance Options

Material

ASTM E2178

0.004 cfm/ft² (0.02 L/s/m² @ 75 Pa)

Lists 15 materials if joints are sealed

Assembly

ASTM E2357, E1677, E283

0.04 cfm/ft² (0.2 L/s/m² @ 75 Pa)

Lists 2 materials if joints are sealed

Test

ASTM E779

0.40 cfm/ft² (2.0 L/s/m² @ 75 Pa)

Code Requirements

2014 OEESC 502.4.1.2.1

Material – provided joints are sealed and installed as air barrier

- *Plywood $\leq 3/8$ inch*
- *Oriented strand board $\leq 3/8$ inch*
- *Extruded Polystyrene $\leq 1/2$ inch*
- *Foil-backed Polyiso $\leq 1/2$ inch*
- *Closed Cell Spray Foam $\leq 1 1/2$ inch*
- *Open Cell Spray Foam $\leq 4 1/2$ inch*
- *Exterior/Interior Gypsum Board $\leq 1/2$*
- *Cement board $\leq 1/2$*
- *Built-up roofing membrane*
- *Modified Bituminous roof membrane*
- *Fully adhered single-ply roof membrane*
- *Portland cement / sand / gypsum plaster $\leq 5/8$*
- *Cast-in-place and precast concrete*
- *Fully grouted concrete block masonry*
- *Sheet steel or aluminum*

Material Testing

ASTM E2178

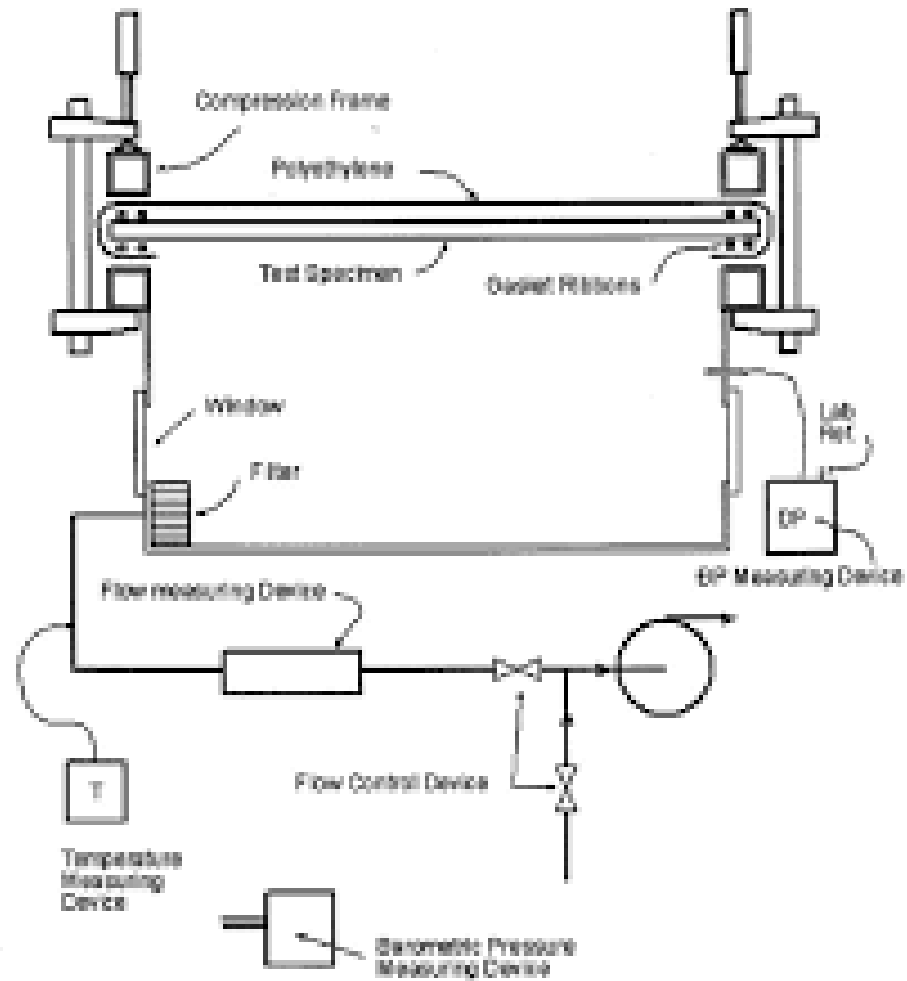


FIG. 1 General Configuration of Test Apparatus



Code Requirements

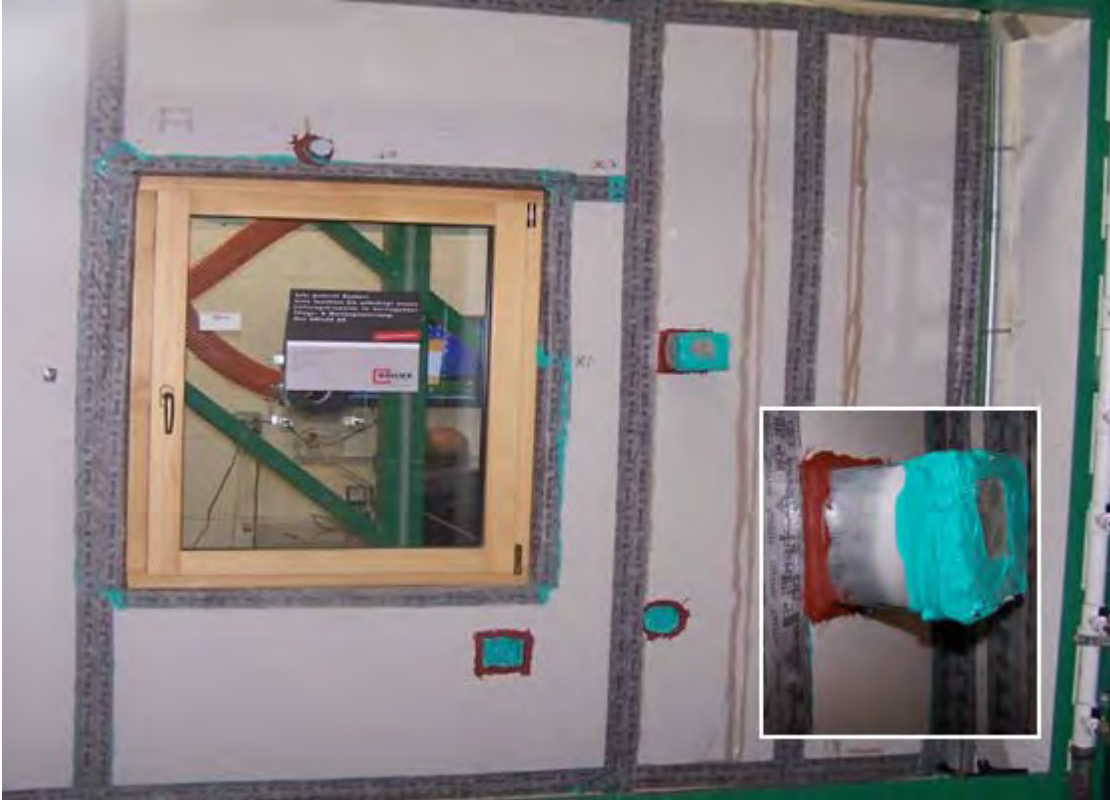
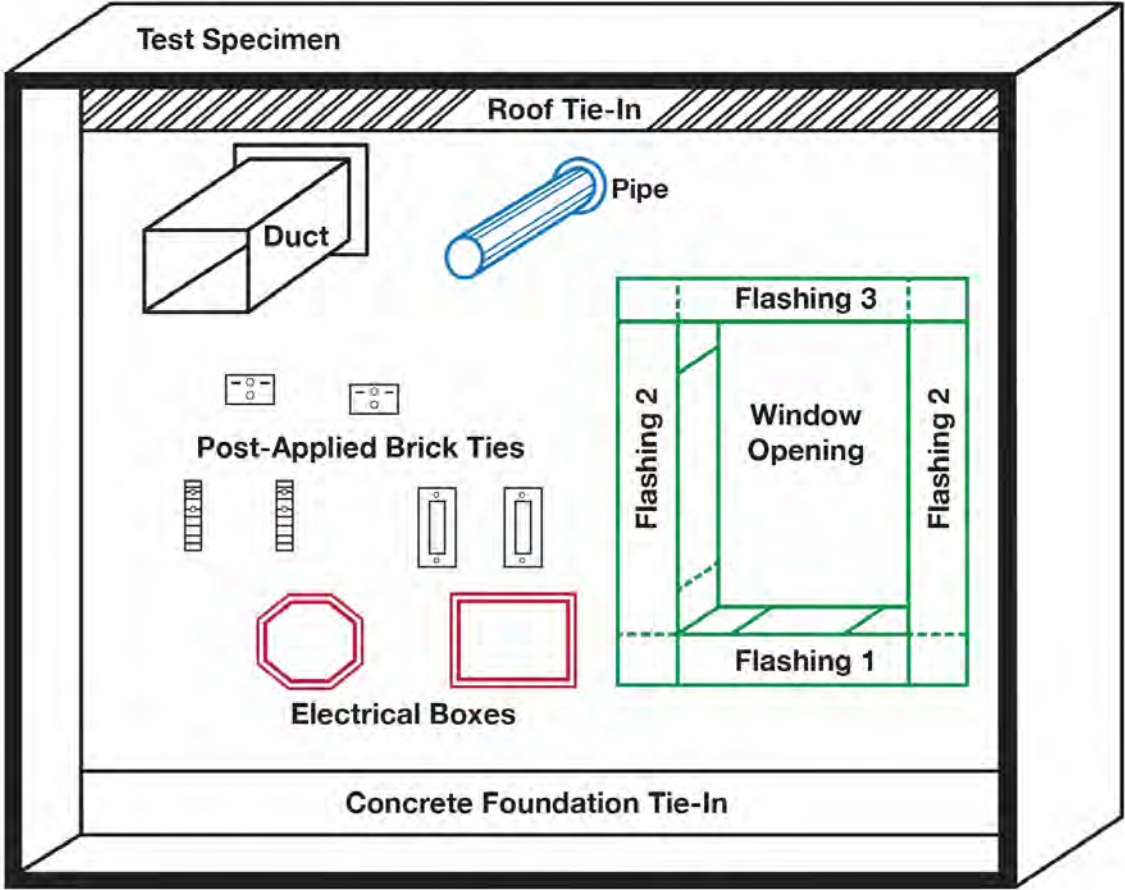
2014 OEESC 502.4.1.2.2

Assemblies – provided joints are sealed and installed as air barrier

- *Concrete or masonry with block filler and paint or sealer*
- *Cement/sand parge, stucco or plaster $\geq \frac{1}{2}$*
- *ABAA Resource for many tested assemblies*

Assembly Testing

ASTM E2357, E1677, E283



Code Requirements

2014 OEEESC 502.4.1.1

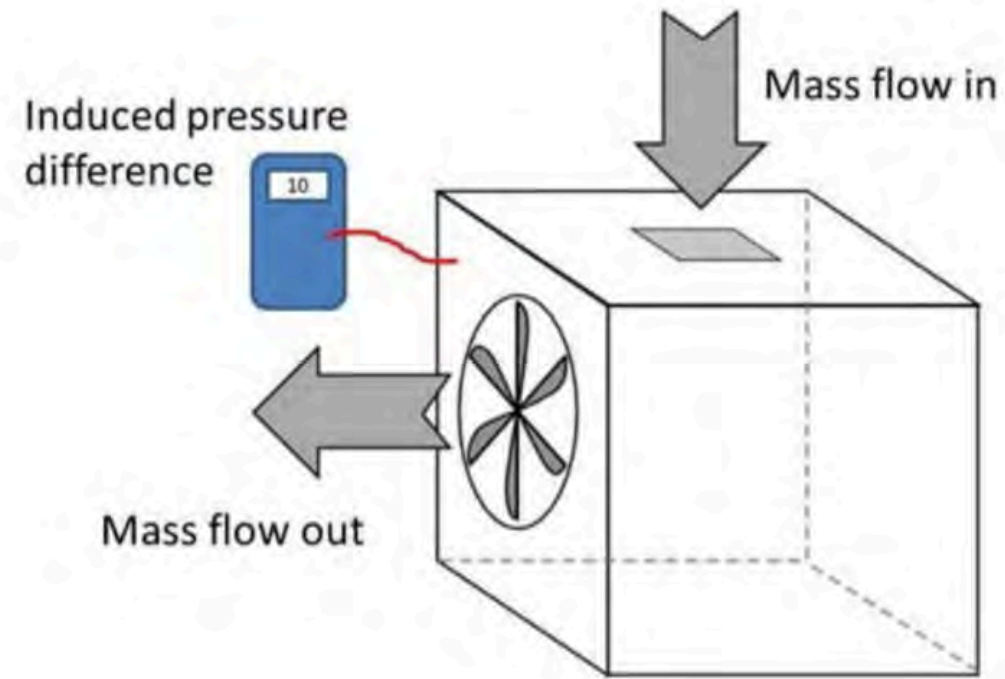
Air Barrier Construction

- *Continuous across joints and assemblies*
- *Joints and seams to be sealed*
 - *Changes in materials*
 - *Entire length and secure so not to be dislodged*
 - *Withstand pressure from wind, stack effect, mechanical ventilation*
- *Penetrations*
 - *Caulked, gasketed, sealed – withstanding pressure*
- *Recessed light fixtures*
 - *Rated and sealed/gasketed*

- *Exception: Building Test*

Building Test

ASTM E779



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

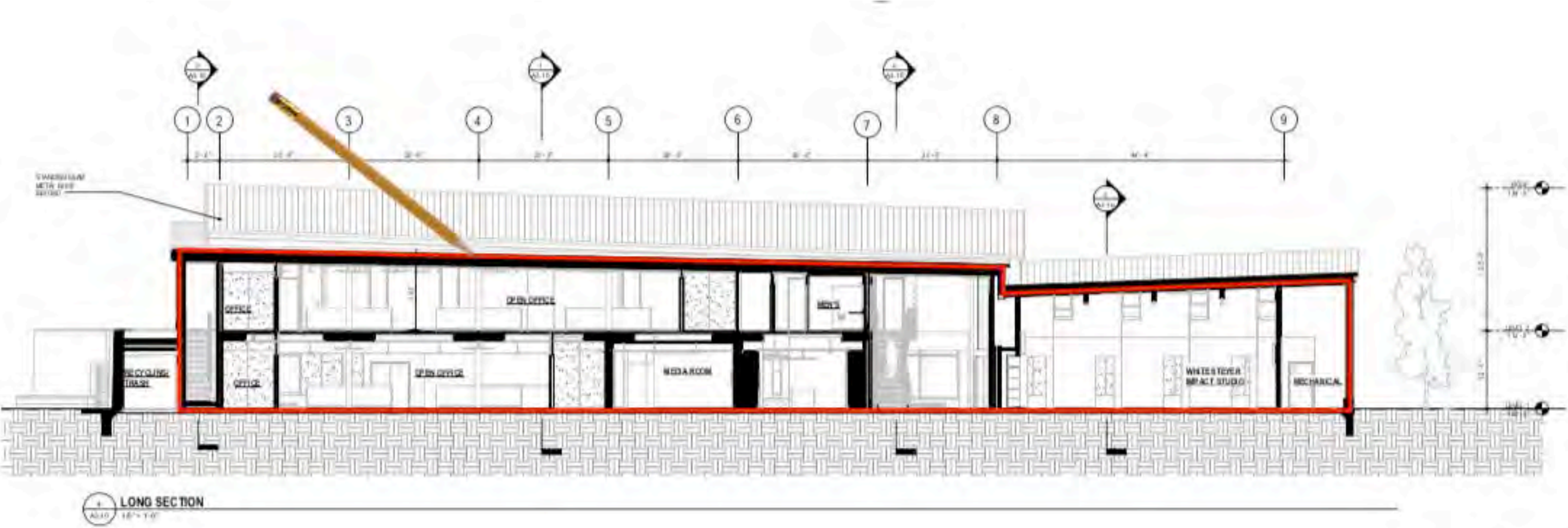
0.08 cfm @ 75 Pa / ft² – Passive House 6+ stories 0.05 cfm/ft² others

Or 0.6 ACH @ 50 Pa - Passive House International

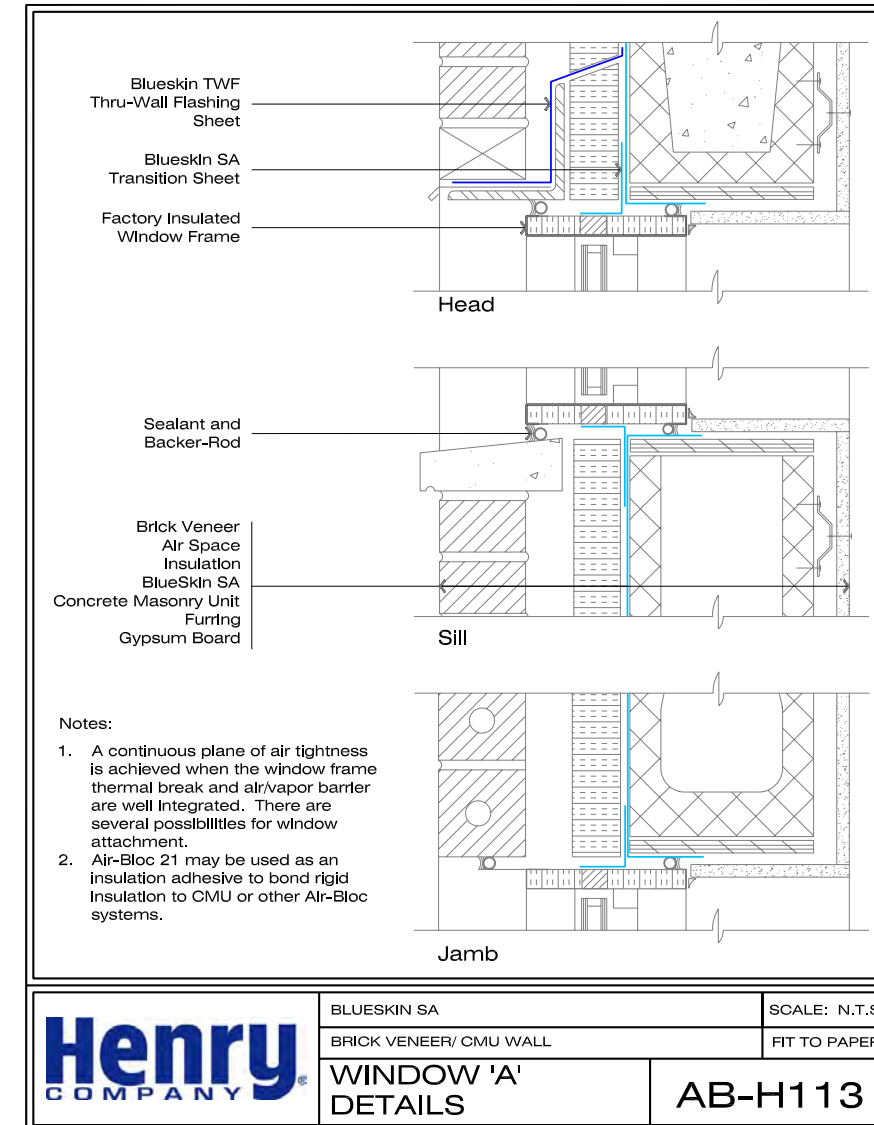
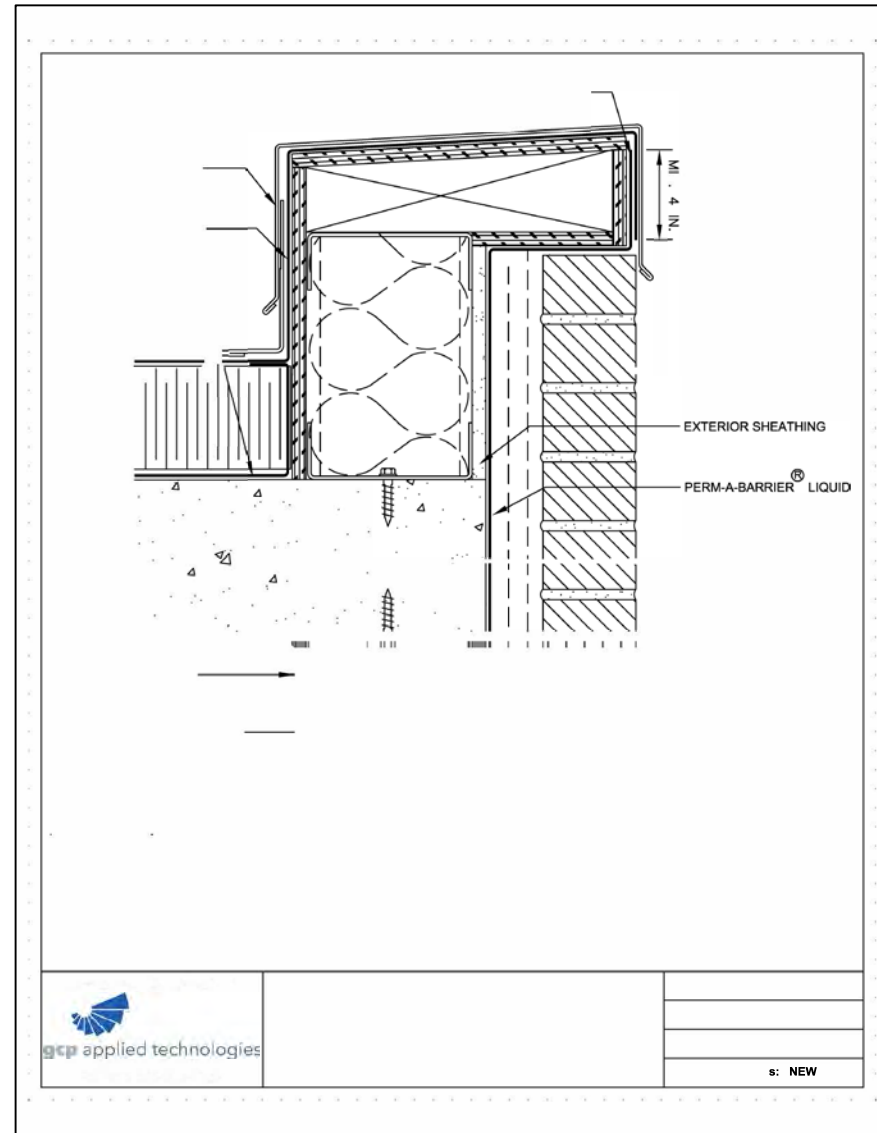
Common Approaches



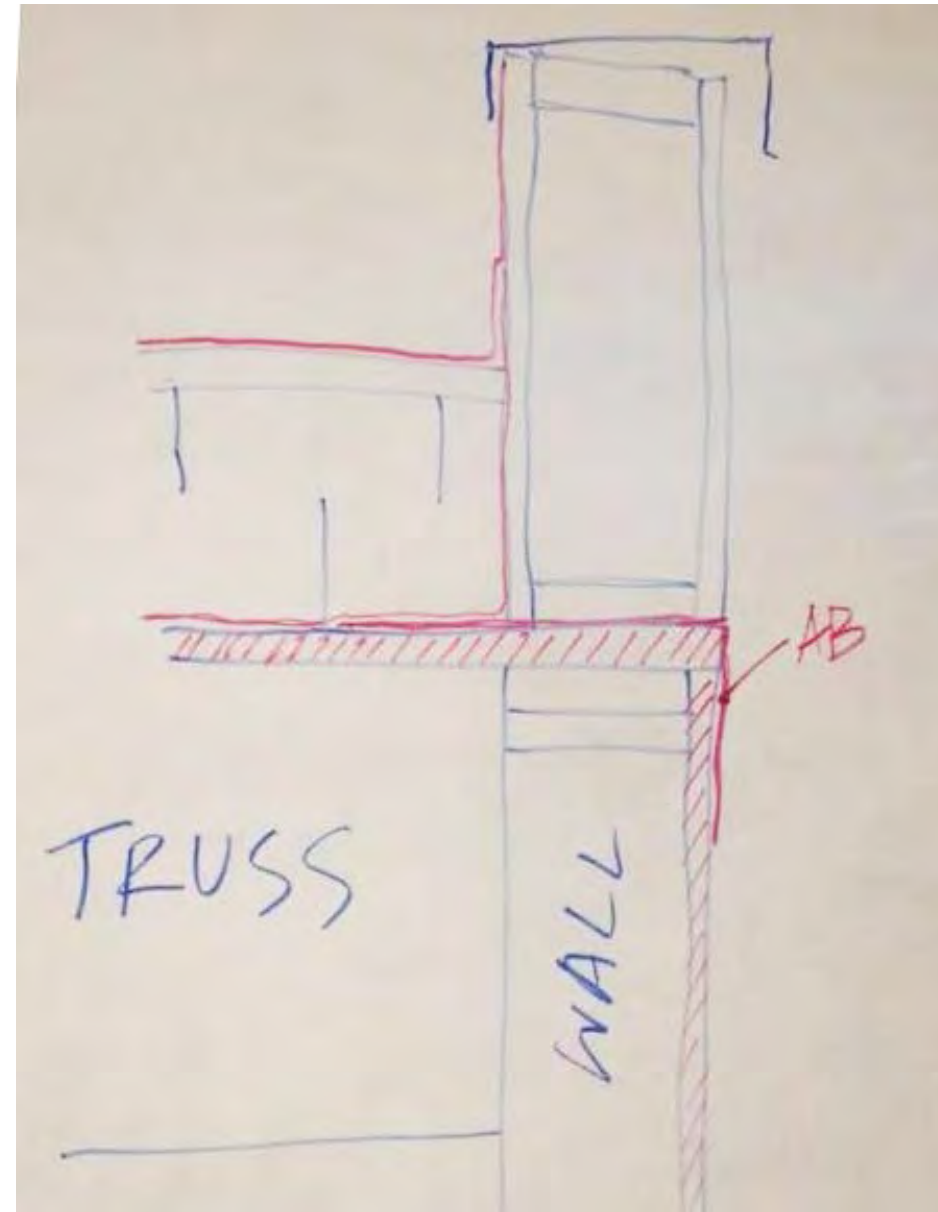
Air Barrier Design



Manufacturer Details



Design-Build Details



Specifications

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*

Pre-Construction Meetings

- Even more essential for a successful execution
- Should be in the Specifications
- Allows coordination of trades and resolution of final questions
- Consider designated Air-Tightness Coordinator

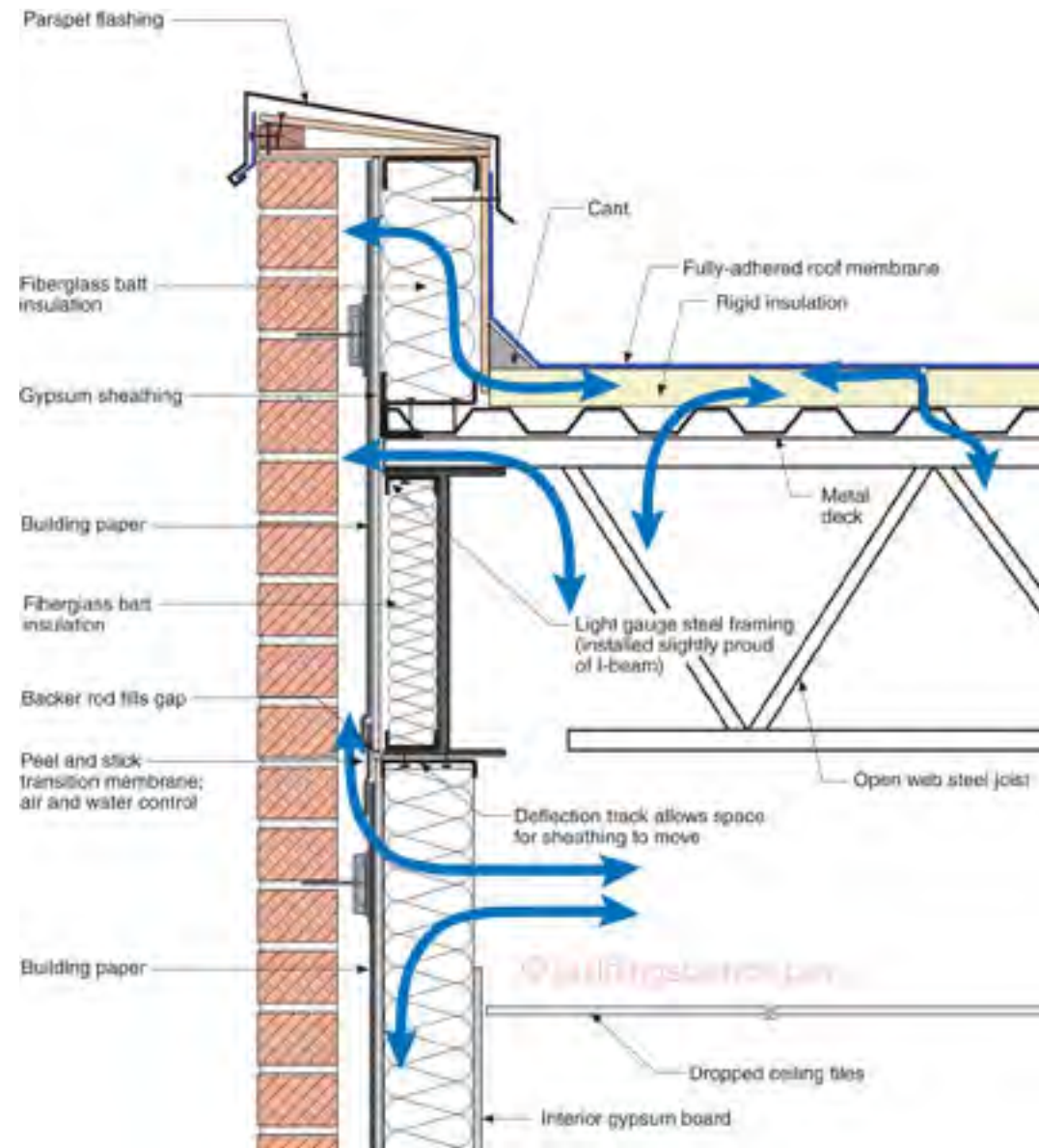


Mock Ups

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



Why System Testing



Air Tightness Test

Orchards of Orenco Phase 1



Sealing intentional openings

Mechanical and other intentional openings are covered during the test.

However, leaking dampers can increase leakage by 40-70%.



When to Test

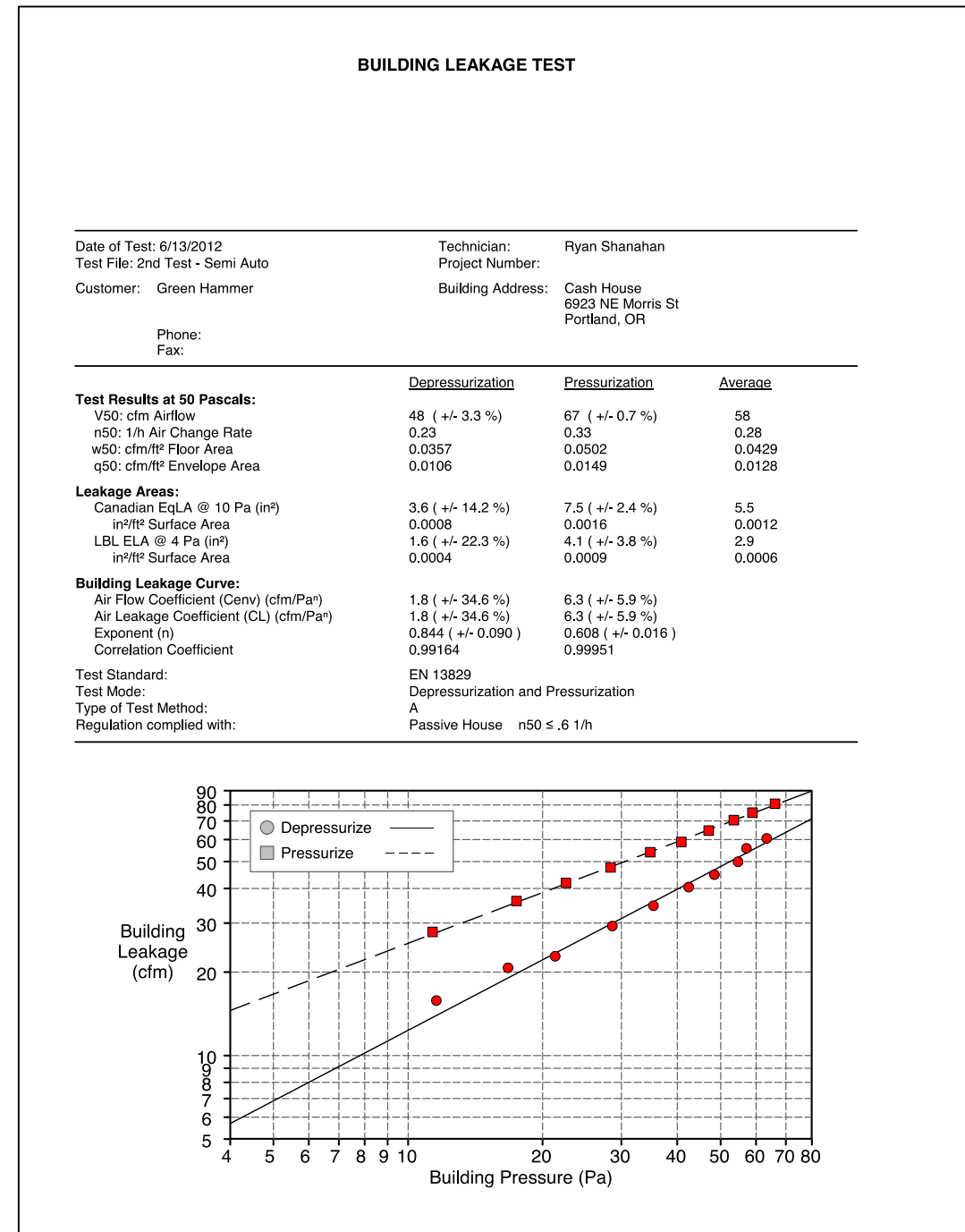
As early as possible!

- Air barrier need to be complete (sequencing can be difficult)
- Easier test prep if duct work isn't finished
- Better test results
- Better opportunity for remedial work

Test Results

Testing Protocols

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



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*

Questions?

Thank you!

*Alex Boetzel
Green Hammer*