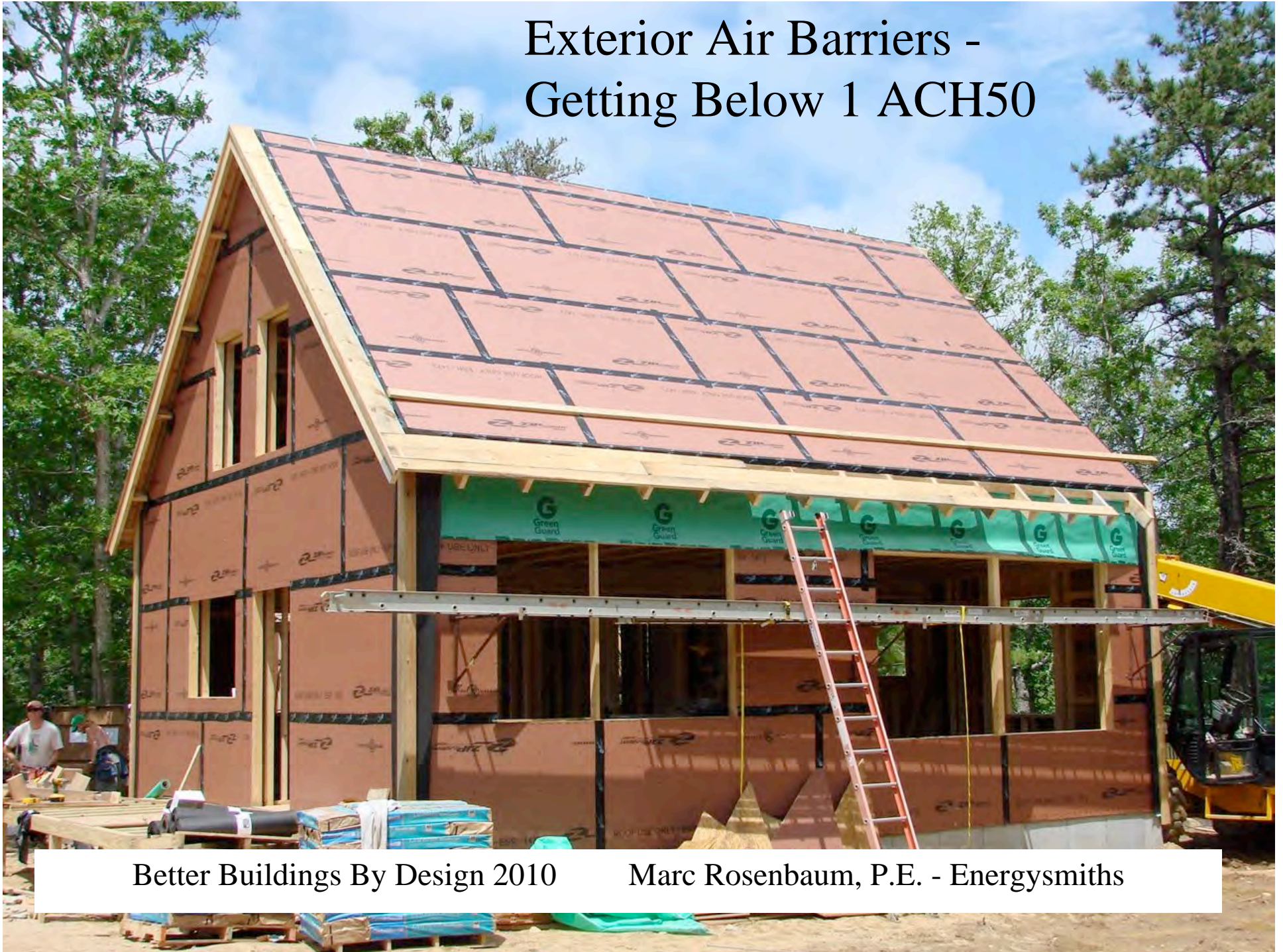


Exterior Air Barriers - Getting Below 1 ACH50



Better Buildings By Design 2010

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This presentation addresses:

- What is an air barrier (AB) and why do we need one?
- How to specify air tightness and how to test it
- Why put the AB on the exterior ?
- What issues does an exterior AB raise?
- What are examples of exterior ABs?
- What are the key areas of concern and how can they be addressed?

Air Barriers

An air barrier is a critical part of a superinsulated house. It is a system of materials that control air flow through the building enclosure. It needs to be:

- Impermeable to air
- Continuous
- Strong enough to resist forces on it
- Durable

The air barrier can be inside, outside, or in the construction assembly.

An air barrier *can* also be a vapor diffusion retarder, in which case it's best if it's not on the exterior in VT.

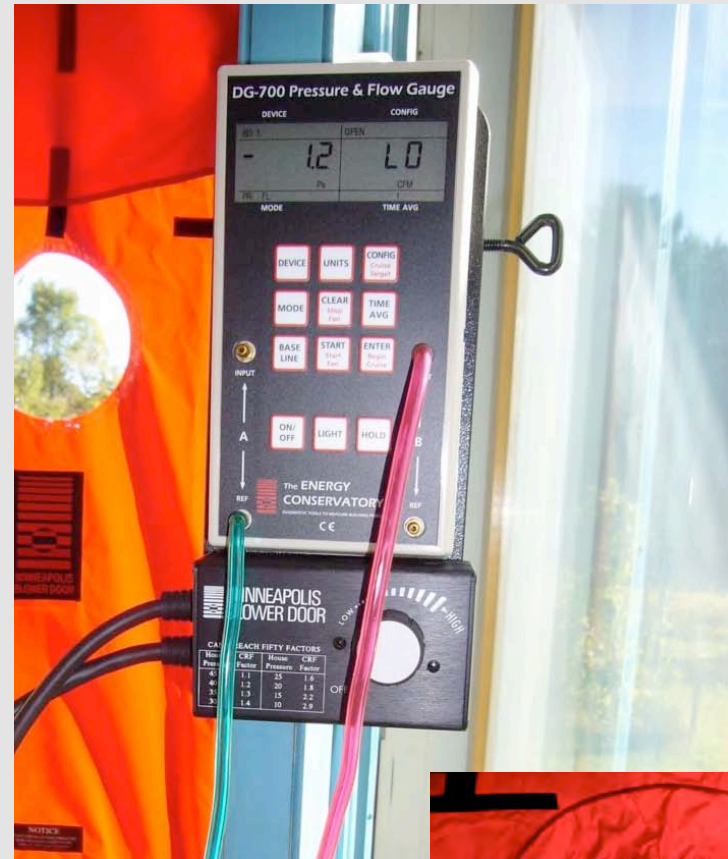
Why Bother?

- As envelope thermal resistance increases, air leakage becomes a larger portion of the total heat loss
- The principal damage mechanism in wood frame buildings is uncontrolled moisture transport, and the majority of water transported in the vapor phase is associated with air leakage
- As air tightness increases, transfer of sound, odors, and vermin are all reduced
- Control of where air enters the building can improve indoor air quality, because the air can be filtered and the pathway monitored for cleanliness

Testing Air Tightness

- Air tightness is tested with a blower door, which depressurizes the building with a calibrated fan and measures how much air flow is needed to depressurize the building to 50 Pascals.
- A blower door can also be used effectively to locate areas of leakage. Either a smoke pencil or a theatrical fog machine can be used to make the leakage visible.

Blower Door



Finding the Leaks with Fog



Smoke pencil

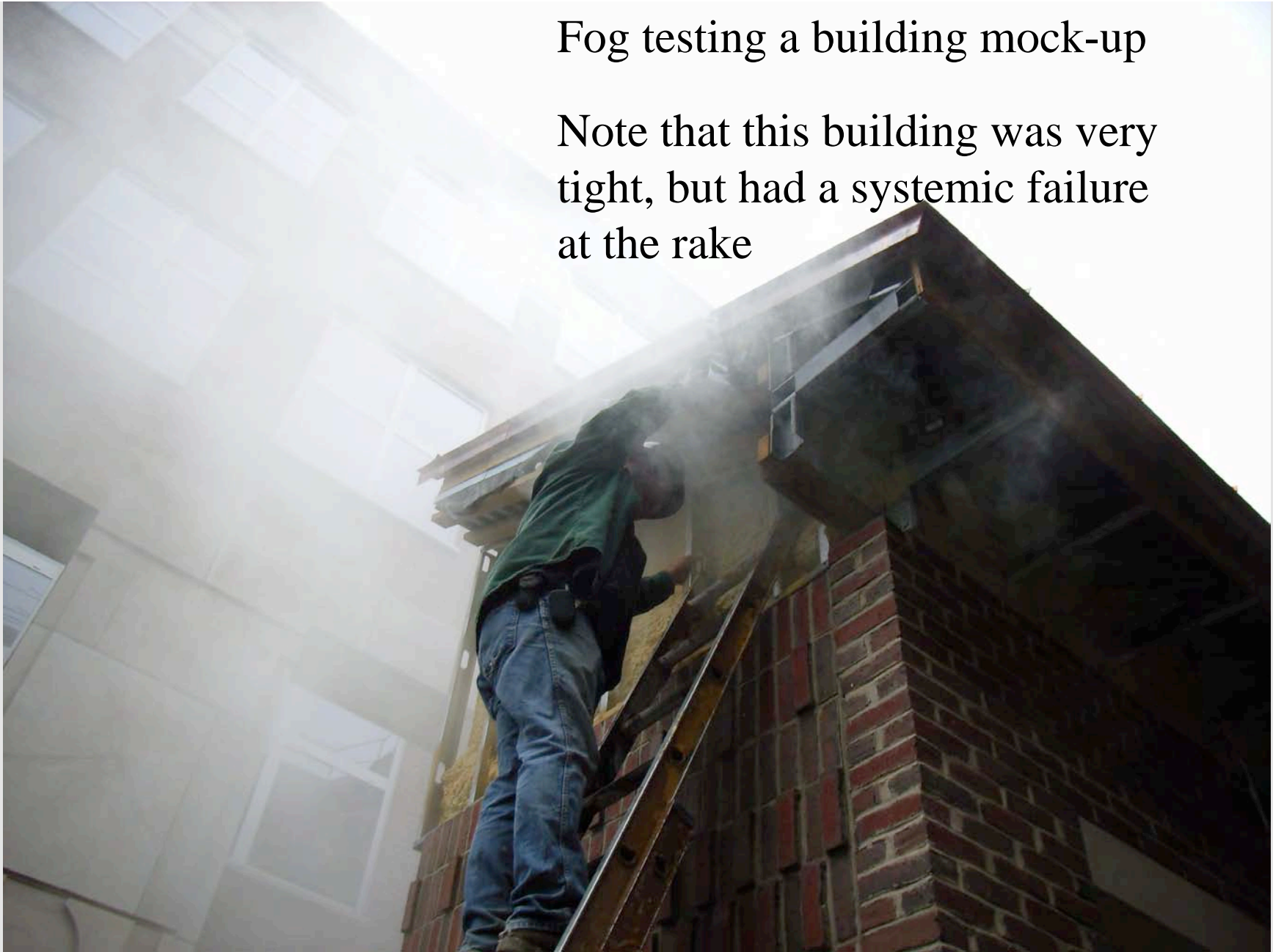
Fog machine



- Using theatrical fog with a blower door is a qualitative test that helps evaluate the success of the AB design and implementation as the construction process is occurring.
- The objective is to identify areas where the AB is not effective, either due to design or construction defects.
- The blower door pressurizes the building (or a portion of it) and fog is introduced inside, and fog appearing at the exterior is evidence of a leakage path.
- Temporary enclosures are often used to test a “first instance” of an assembly, for example a corner of a building that includes walls, wall-wall junction, wall-roof junction, and window installation.

Fog testing a building mock-up

Note that this building was very tight, but had a systemic failure at the rake

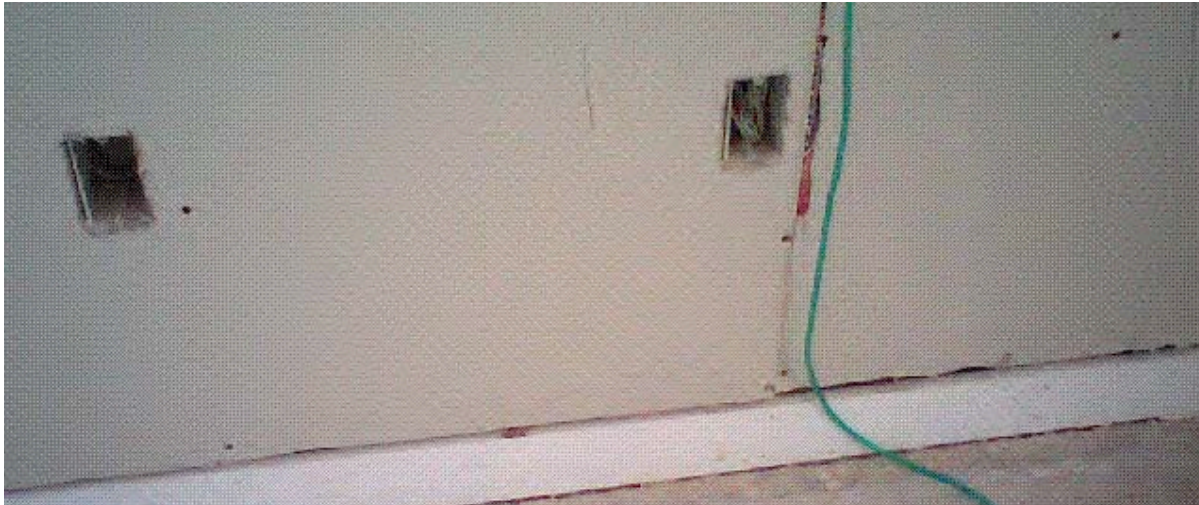


Poly partition to isolate a space for testing



Infrared Scanner

- Another method for performing in-process quality assurance is to use an infrared scanner.
- Usually the building is scanned from the inside without the blower door operating, then the blower door is set to depressurize the building, and run for enough time (10-15 minutes) so that an assessment can be made distinguishing conduction issues from air leakage issues.



Visible light image



Infrared image



Specifying Air Tightness

- An air tightness spec can be in terms of air changes per hour at 50 Pascals (ACH50), Equivalent Leakage Area per 100 sf of shell (ELA/100 sf shell), or CFM50 per sf of shell (CFM50/sff). I prefer CFM50/sff, because it normalizes all buildings regardless of size
- A typical older home can easily be 1 CFM50/sff
- A minimum target for a superinsulated home should be 0.10 CFM50/sff. Desirable is 0.05 CFM50/sff or less.

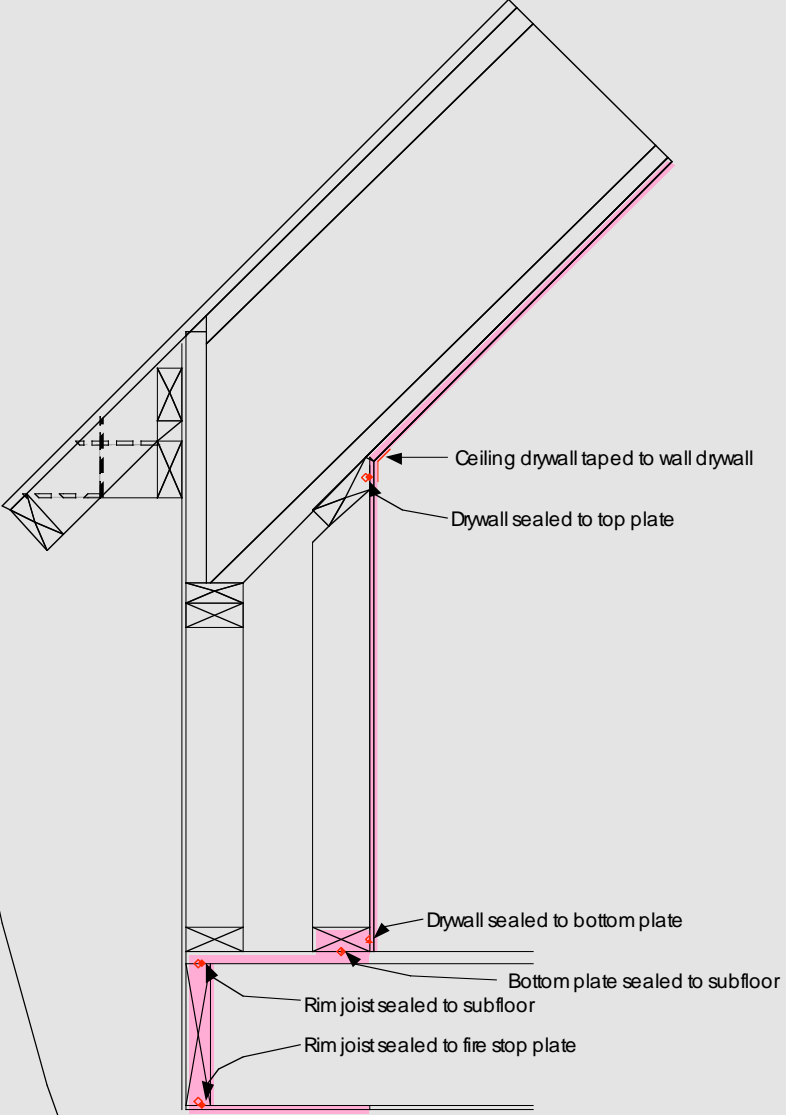
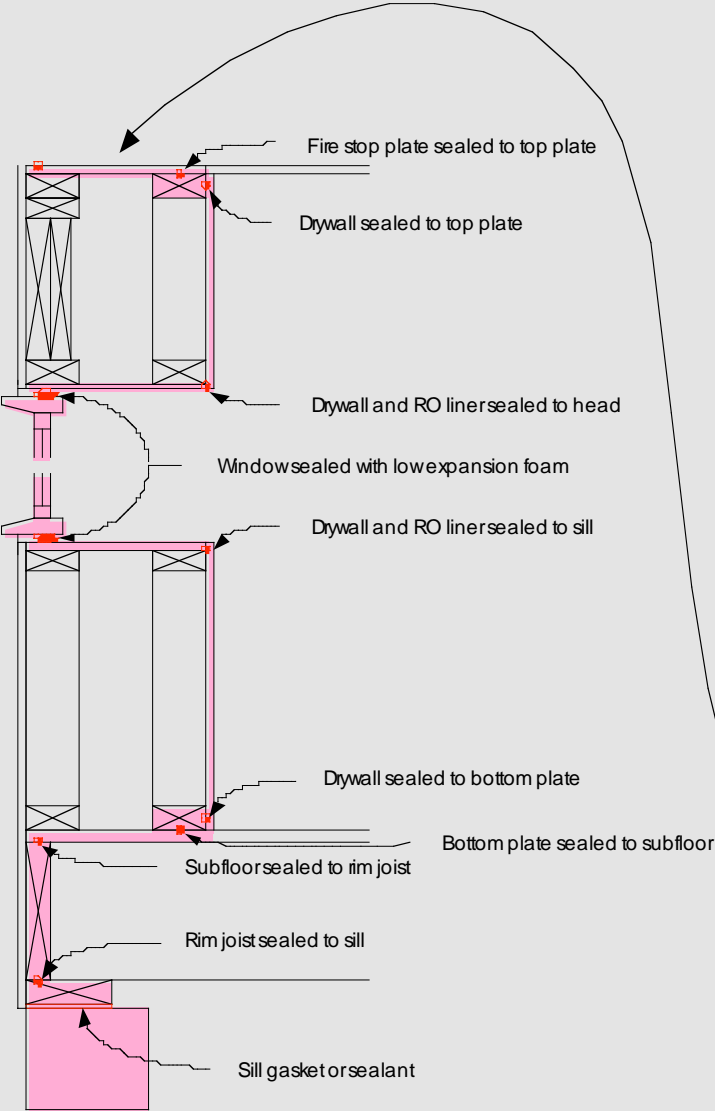
Compare:

Building	CFM50 for 1 ACH50	CFM50 per sf of shell (all 6 sides)
1,200 sf house, 2 story, slab on grade (10,200 cf)	170	0.06
4,000 sf house, 2 story, slab on grade (34,000 cf)	567	0.08

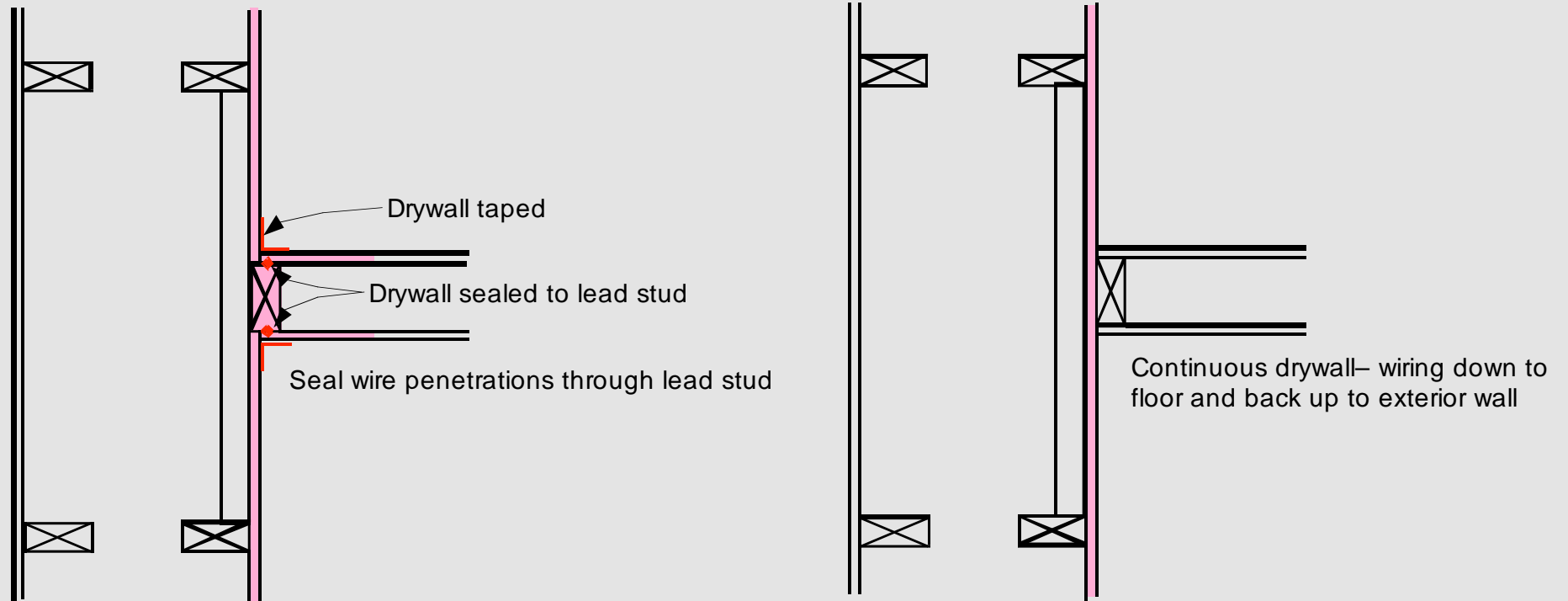
Why an Exterior AB?

- Fewer intersections to seal
- Clear location at which to seal all penetrations
- Increased design complexity easier to accommodate
- Sheathing is durable
- Visible and verifiable
- Testable early

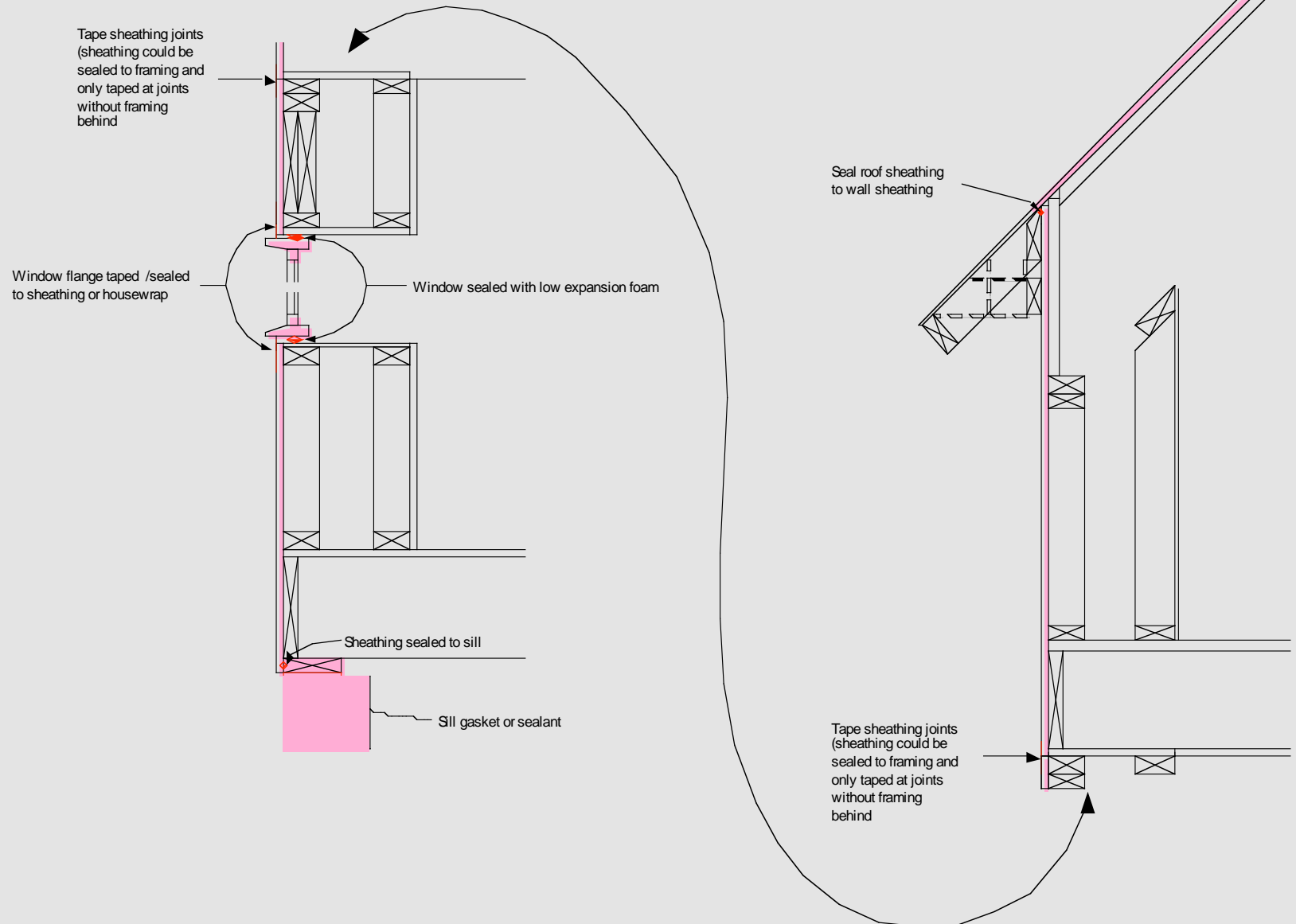
Inside Air Barrier



Partition Intersections



Exterior Sheathing Air Barrier



Requirements for Exterior AB

- The ideal air barrier material would be an air impermeable, yet vapor permeable, structurally rated sheathing that has a surface that is easy to seal at joints. Moisture that gets into the cavity keeps moving on out.
- One way to address the concern about semi-permeable sheathings (OSB, for example) is to add a significant amount of additional insulation outside the sheathing to keep the sheathing warm
- The cavity fill insulation must be very resistant to air movement so that air doesn't move between the indoors and the cavity, transporting moisture
- The end result must be very tight - say 0.10 CFM50 per sf of shell

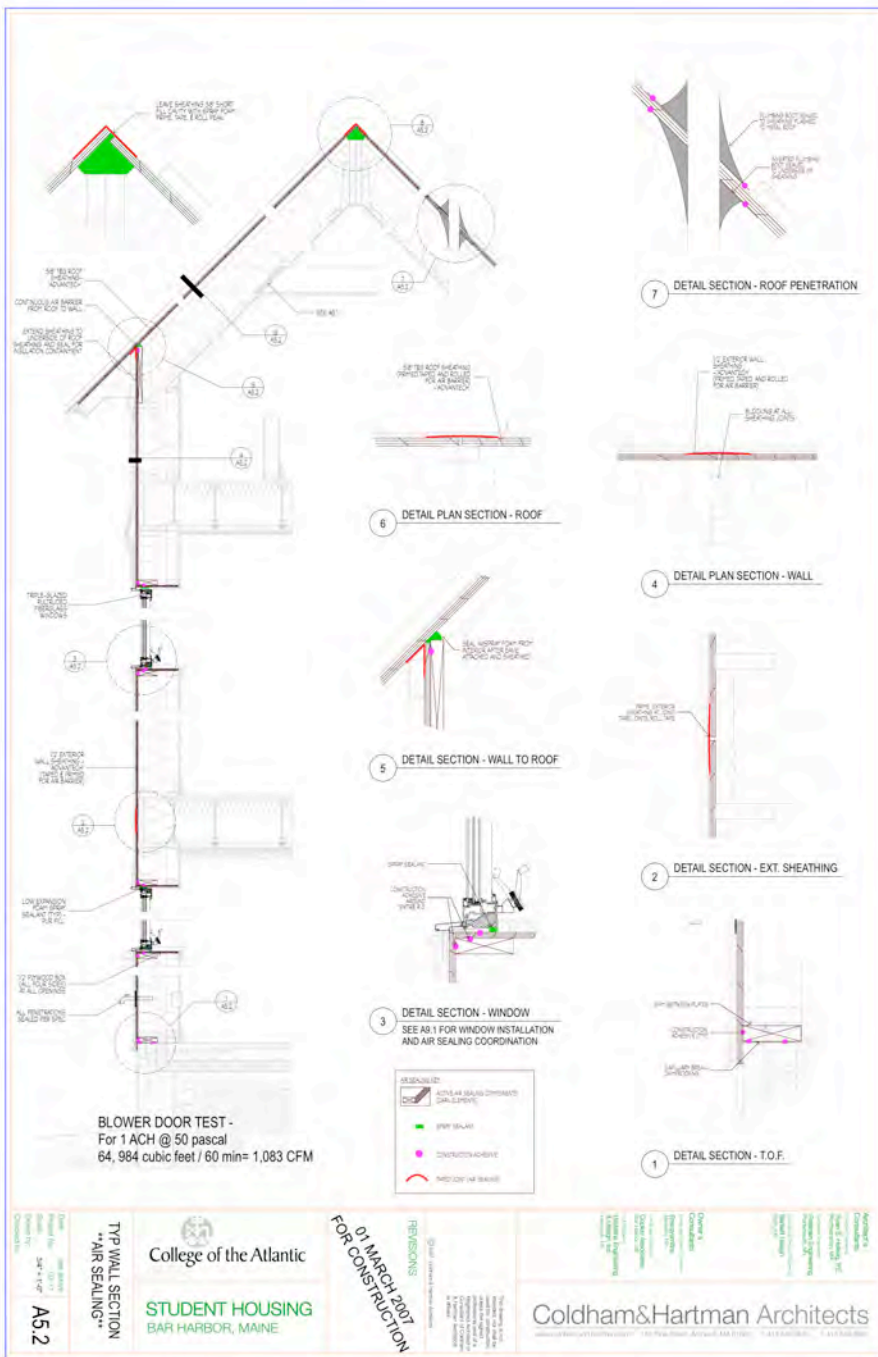
Approaches

- Plywood or OSB sheathing taped with a peel-and-stick tape
- Huber's engineered Zip system with a faced OSB and proprietary tape for the seams
- A roll-on or spray-on rubberized coating such as STO Guard which is applied over sheathing and is the substrate for adhering foam to the sheathing

In any of these systems, the edges of the sheathing that don't abut other sheets of sheathing are sealed to the framing (sills, rough openings).

- Another approach to seal the sheathing is to use a flash coat of closed cell spray polyurethane foam against the inside face of the sheathing
- Foil-faced rigid foam can be taped as an exterior AB yet it is more challenging to get an excellent result

- If tape is used to seal the sheathing joints (as opposed to adhesives, caulk, or gaskets) it must be compatible with the sheathing and the appropriate primer must be used.
- Typical products are Vycor Plus (walls) and Roof Detail Membrane (WR Grace) – generically this is rubberized asphaltic membrane with a polyethylene backing, about 25-40 mils thick.
- Huber's Zip system is faster and less costly
- STO Guard uses a three step process - mesh tape at seams, Gold Fill over mesh and over fasteners, the Gold Coat over the entire surface
- The sheathing could be caulked at all perimeter-to-framing locations with similar results but this is not visually verifiable.



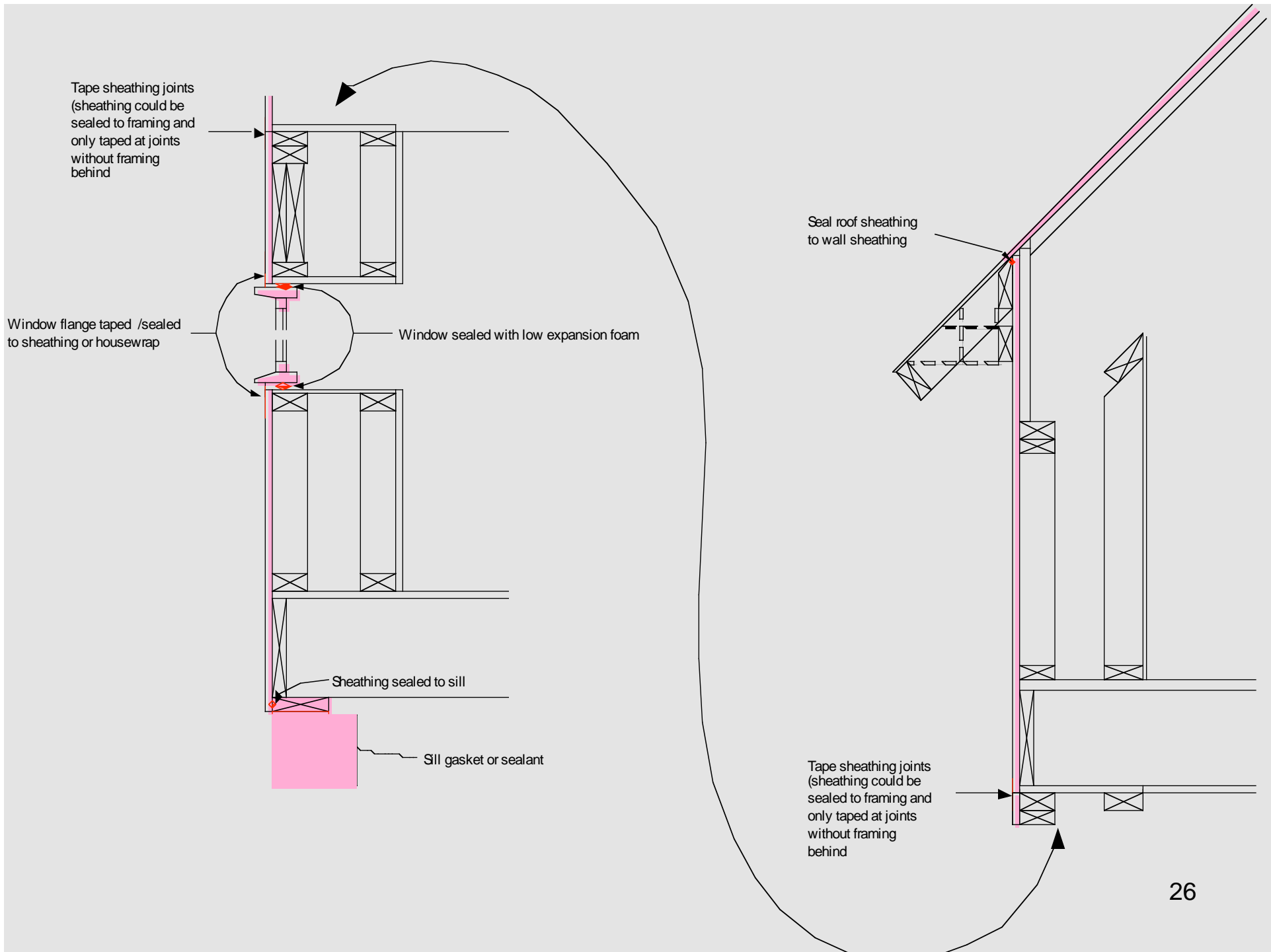
A drawing set should include a separate air barrier drawing like this one drawn by Tom Hartman

College of the Atlantic Student Housing
(3) 6,500 sf duplexes
851 CFM50 average (under 1 ACH50)
Coldham & Hartman



The wall air barrier is taped sheathing, with rigid foam over





250 State Rd Affordable Housing
2 & 3 bedroom capes - <150 CFM50
South Mountain Company



STO Guard coating

- Mesh over joints
- Gold Fill over joints and fasteners
- Gold Coat over sheathing

- Gold Fill 17.3 perms
- Gold Coat 5.7 perms

- Used with EIFS systems, yet could be an effective air barrier without EIFS

3 easy steps to installation



Mesh the joints



Spray Gold Fill® over the joints and spot fasteners

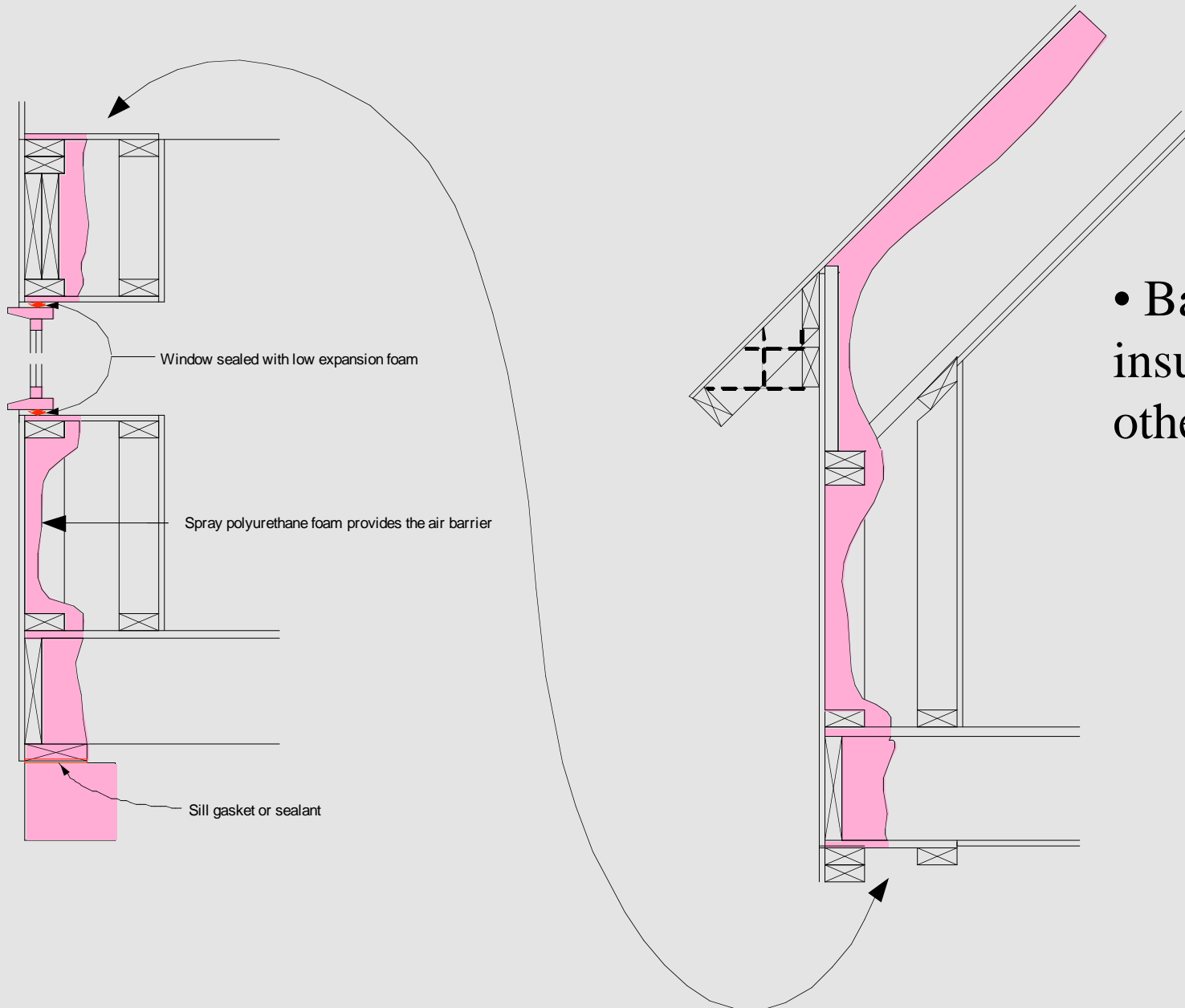


Spray Gold Coat® on the sheathing

Closed Cell Spray Polyurethane Foam

- “Flash” layer of SPF against sheathing combines with sheathing as the AB
- Work is being done from the inside so access to critical junctions must be planned for and maintained during construction
- SPF is trickier to use in cold weather - “winter blend” and skilled installers matter
- SPF doesn’t seal where it isn’t - seal wood-to-wood joints such as subfloor/bottom plate, doubled framing members, etc.

SPF Air Barrier



- Balance of insulation can be other cavity fills



EXTEND TO ROOF
CLOSE INSULATION
WITHIN VENT SPACE

ATION.

HANE

1'-10 1/2"

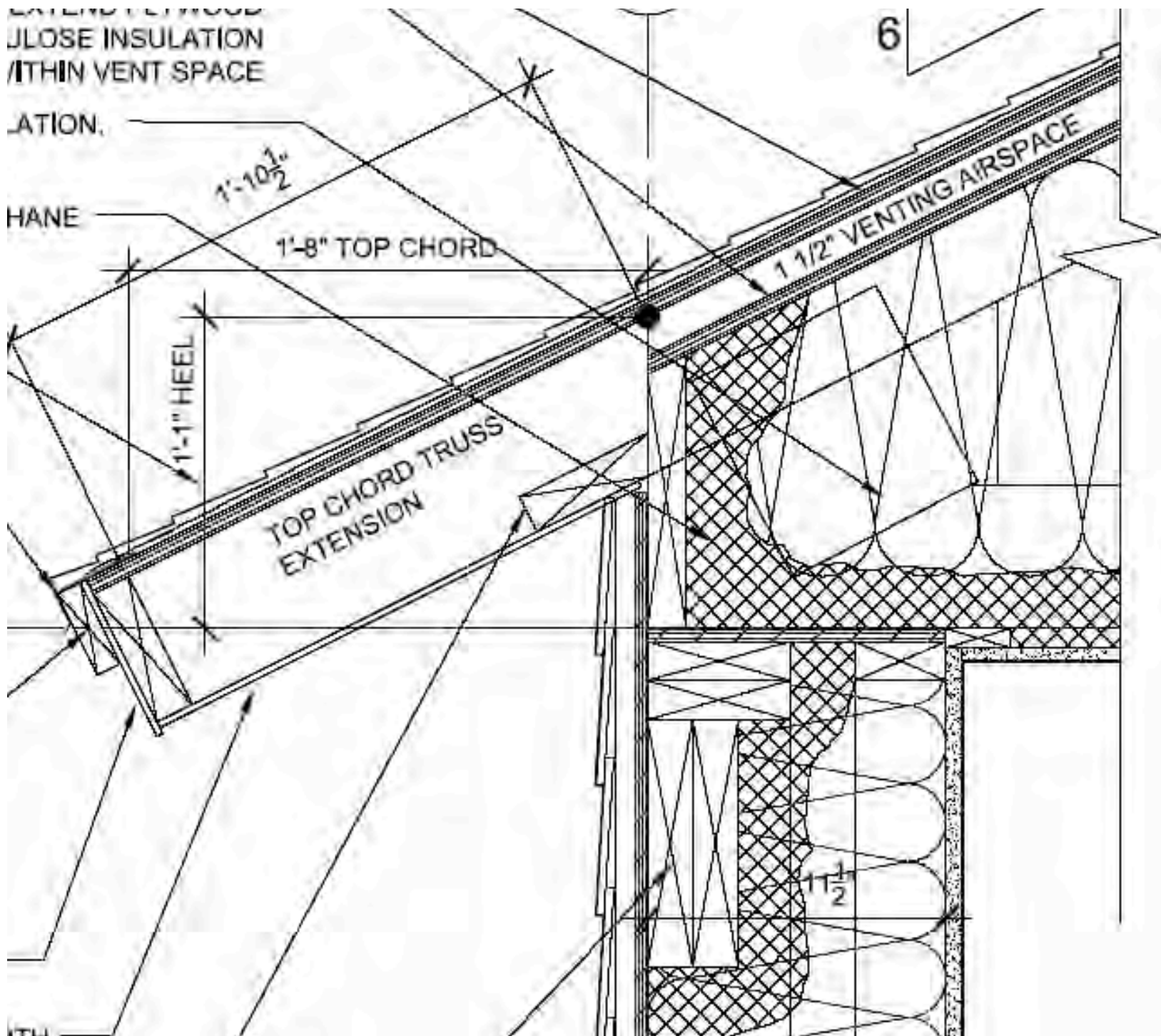
1'-8" TOP CHORD

1'-1" HEEL

TOP CHORD TRUSS
EXTENSION

1 1/2" VENTING AIRSPACE

6





SPF does NOT seal small spaces it is not sprayed directly into



Bement School Dormitory
1,490 CFM50 - under 1 ACH50
Margo Jones Architects



Seal Penetrations



Quickflash flashing panels



Roof boot sealed to air barrier



Seal chimneys

Metal is more challenging, it moves more. Can caulk the gap with a fire-rated sealant.



Note that the flashing is used as an air barrier and is not inserted into the masonry joints – installation and sealing are done after the mason's work.

Sill seals



Gaskets or goop – typical sill seal is too thin to make an air seal, although it is a reasonable capillary break. Hold sill seal back 1/2” from inside face to allow caulking.



Low expansion foam @ windows



Low expansion foam @ windows

