Air and Vapor barrier

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Air Barriers

There must be a continuous, durable, strong and stiff assembly of materials that is defined as the* plane of air tightness *in all buildings with conditioned space
= Air Barrier System

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Air Barriers vs Vapor Barriers

- ***Vapour Barriers Control Vapour Diffusion***
  - Why? 1. Moisture wetting and drying
- ***Air Barriers Control Air Leakage***
  - Why? At least ***six*** reasons.
  - Health (control contaminants)
  - Moisture (avoid condensation)
  - Heat (for comfort & energy considerations)
  - Smoke & odors
  - Sound

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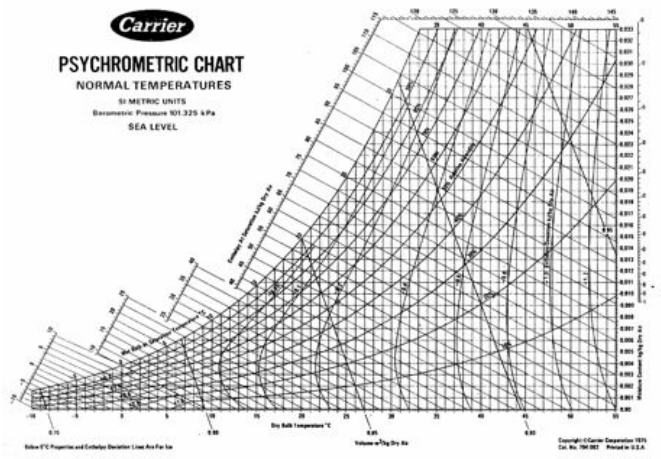
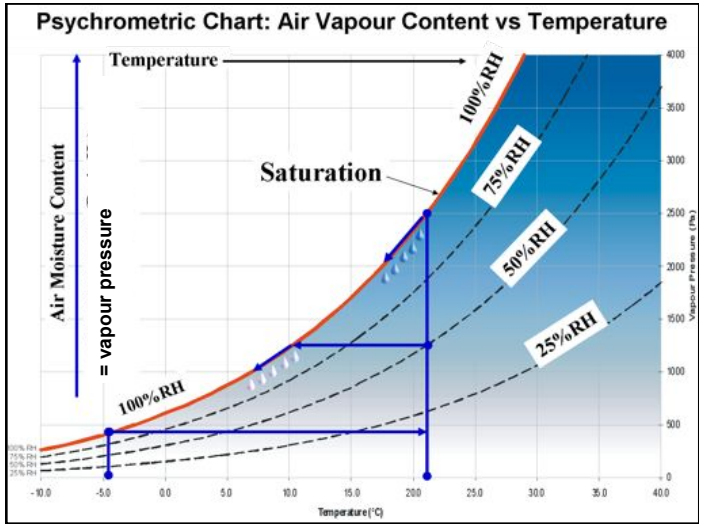
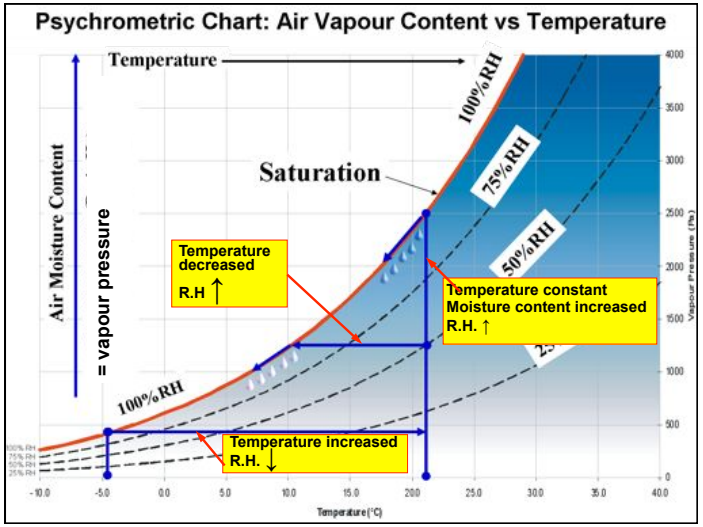
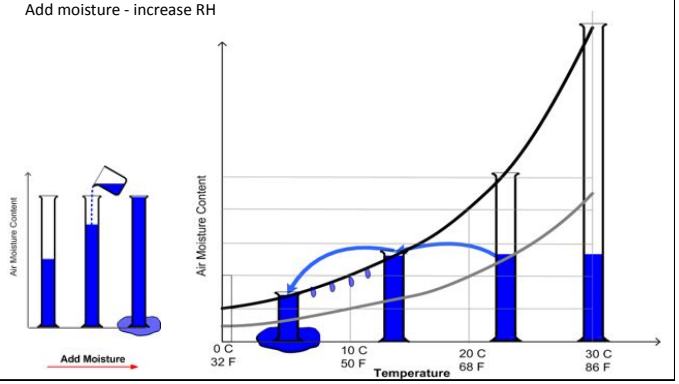






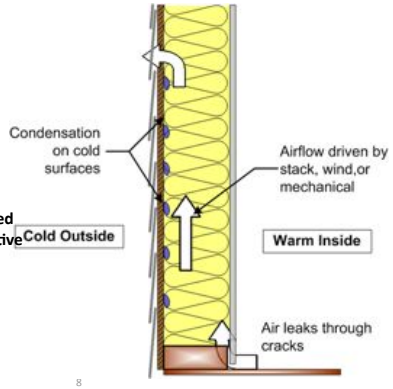
Condensation occurs at 100%RH

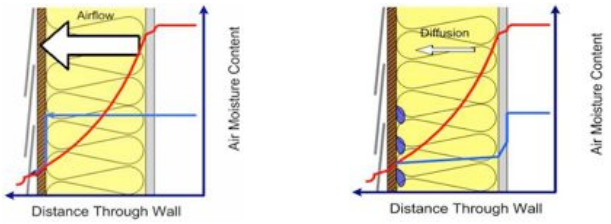
The rules:
Cool air – increase RH
Heat air – decrease RH
Add moisture - increase RH



Air leakage vs Diffusion

- **Air leakage is much more critical**
- **Walls sensitive to diffusion-related condensation will be more sensitive to air leakage**





"The rate of condensation is about ten times that at which vapour might be expected to diffuse through …It seems necessary to assume some other mechanism … the leakage of warm moist air outward ..."

Neal Hutcheon, 1950

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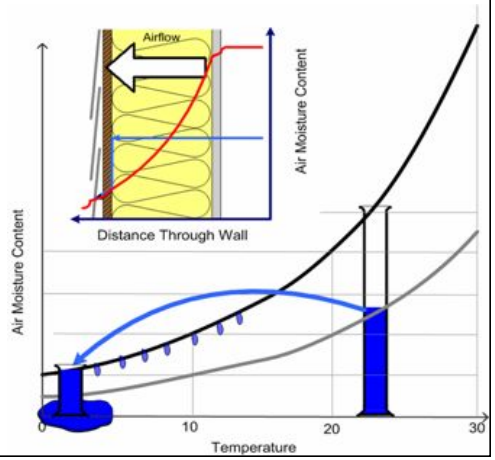
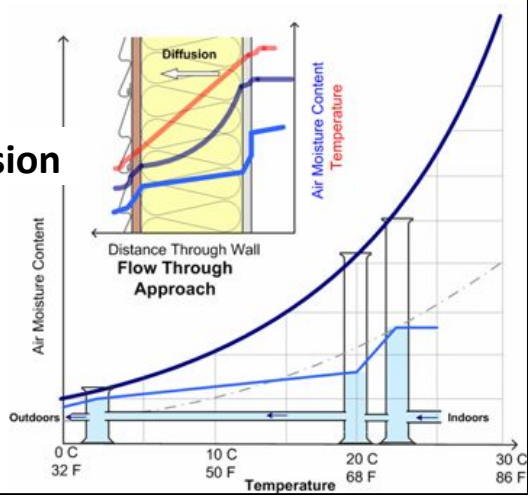
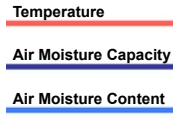
Air leakage



Diffusion

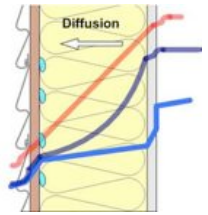


Approaches to the Control of Condensation in Wall Assemblies

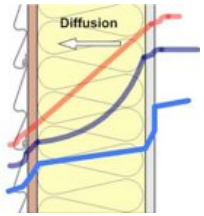


Increase

Decrease



Diffusion & Condensation
(Base Condition)



Flow-through Approach

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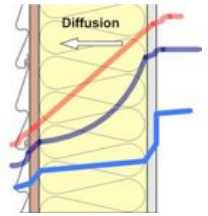
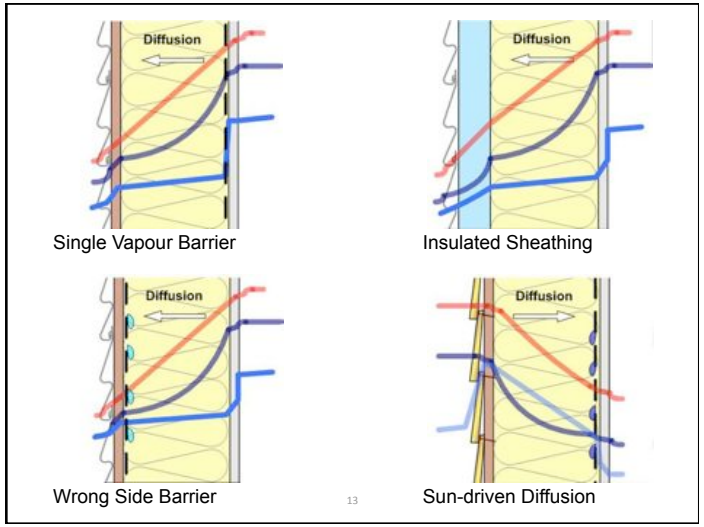
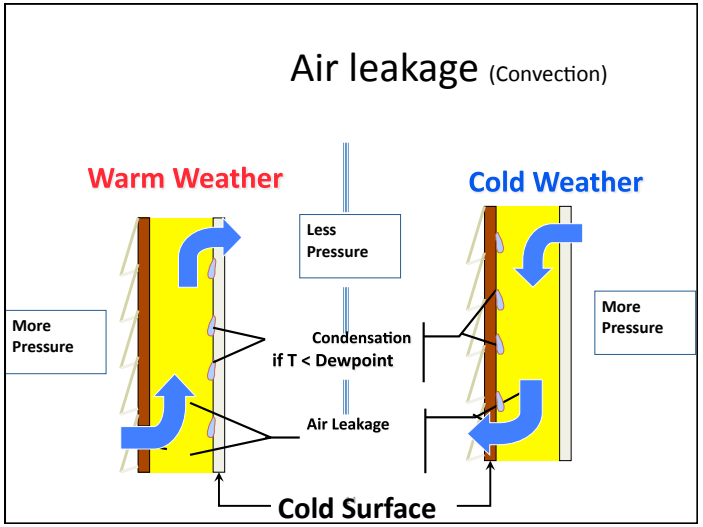
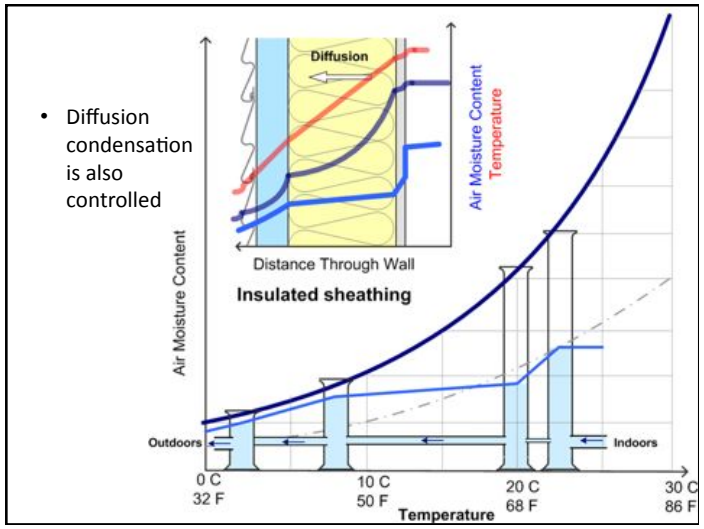


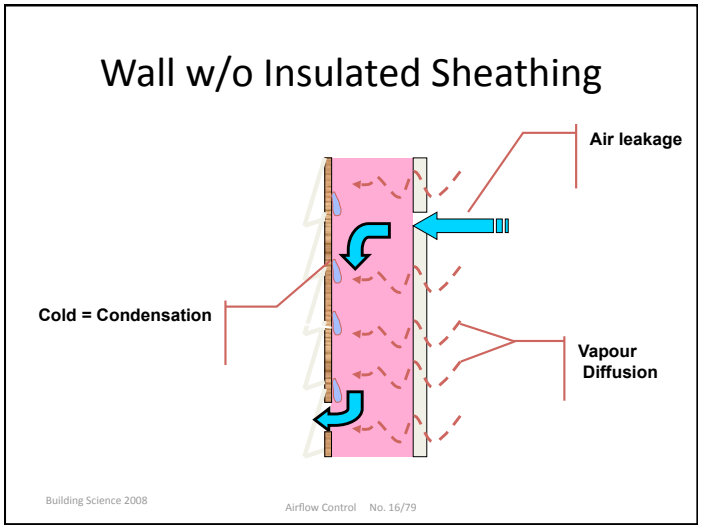
Lower Interior R. H.



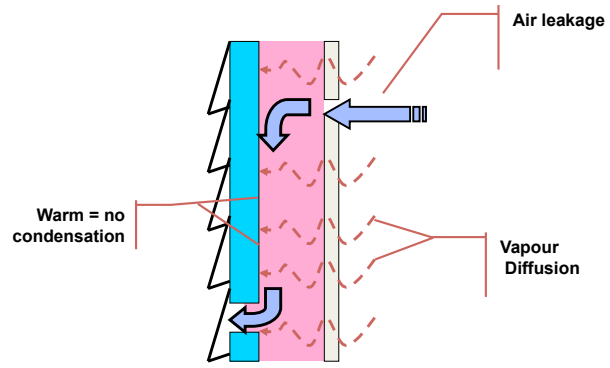


- Diffusion condensation is also controlled

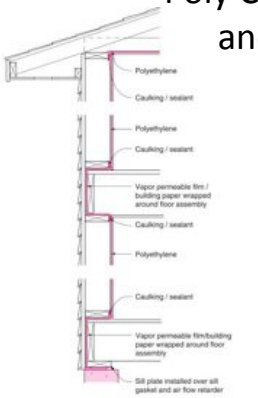




Wall with Insulated Sheathing

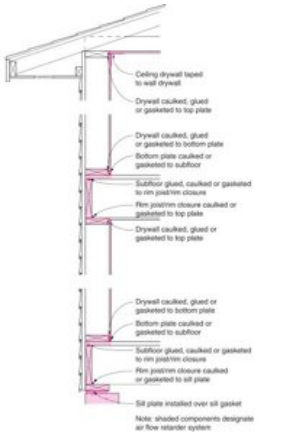


Poly Combined Vapor and Air Barrier



- Combined vapor diffusion and air leakage control
- Thin membrane needs support
- Hard to glue to poly

Interior Air Flow Retarder Using Polyethylene

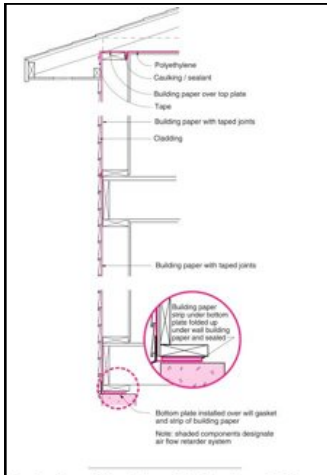


The Airtight Drywall Approach

Use drywall & framing members, sealed with sealant, gaskets, etc.

- **Is stiff, strong**
- **Often easier to get train**
- **Usually can achieve good airtigtness**

Interior Air Flow Retarder Using Drywall and Framing



Exterior Air Flow Retarder Using Building Paper or Housewrap

Housewrap Air Barriers

- Exterior is easy to build
- Thin membranes require support
- Special details required for housewrap, eg CCMC air barrier requirements
- Paper products usually not strong enough
- Paper and housewrap help with windwashing

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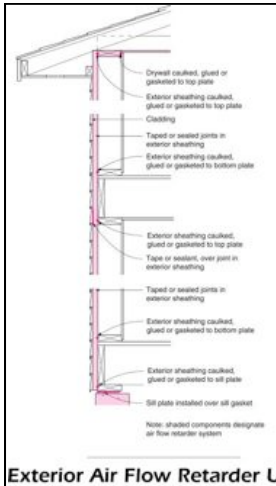

Exterior Air Flow Retarder Using Exterior Sheathing

Sheathing

Exterior easy to build

Stiff materials improve performance

Fastening and sealing joints are difficult

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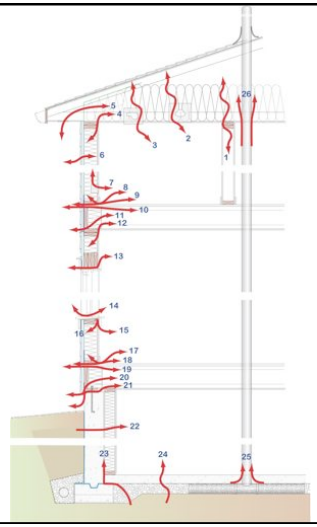

Enclosures No. 23 /

Airflow Within Enclosures

More than just air barriers!

1. Convective Loops
2. Wind washing
3. Pumping

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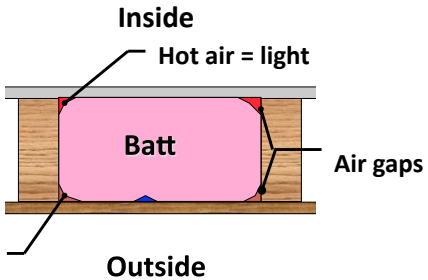
Convective Loops

• Gaps in batt insulation on both sides due to normal installation



Common performance problem

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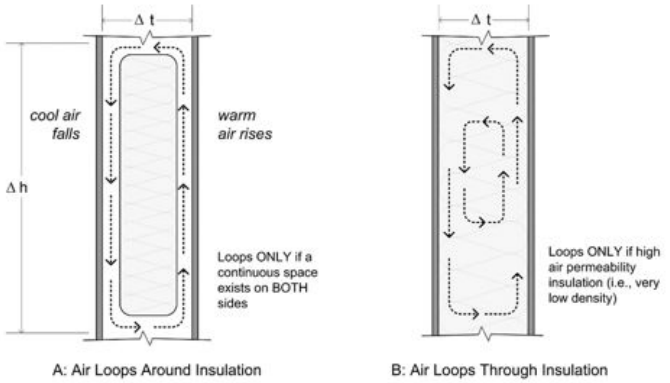
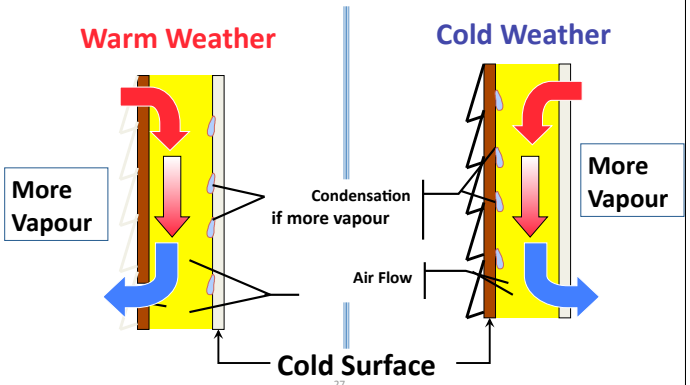
Convective Loops



Air movement (Stack Effect)



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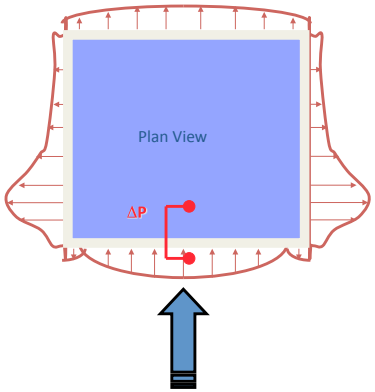
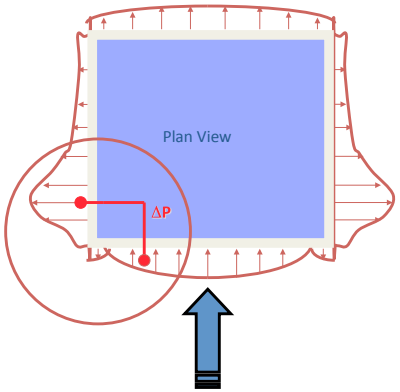
Windwashing

- Need some airtightness outside air permeable insulation (fiberglass, cellulose)
- Sealed housewrap, attached building paper
- Sheathing sealed with tape
  - both OSB and insulated sheathing
  - high density MFI?
- Air impermeable cavity insulation
  - Open cell or closed cell foam

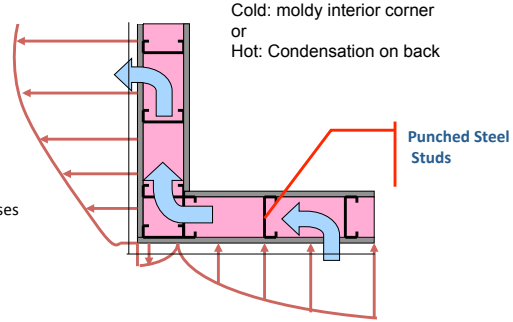
Air Barrier: Pressure Distribution



Windwashing Pressure Distribution



Lateral Airflows

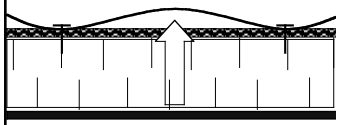


Combined rigid air barrier- drainage plane

Pumping Airflow and Adhered Membranes

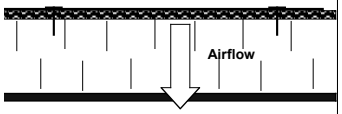
- Membrane is continuous and airtight but …
  - It may not control airflow if not fully adhered or supported
  - E.g. roofing, housewraps, poly

1. Outside= negative pressure gust

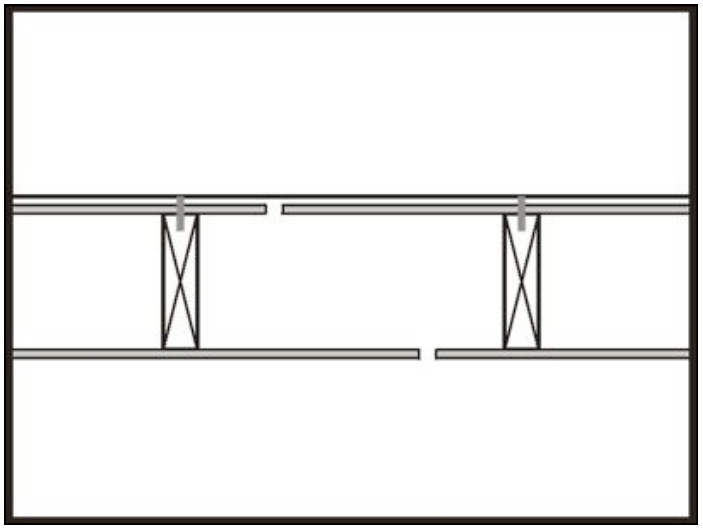


- Membrane balloons outward
- Airflows into roof

2. Outside= positive pressure gust



- Membrane pressed tight to sheathing
- Airflows out of roof



Pumping Solutions

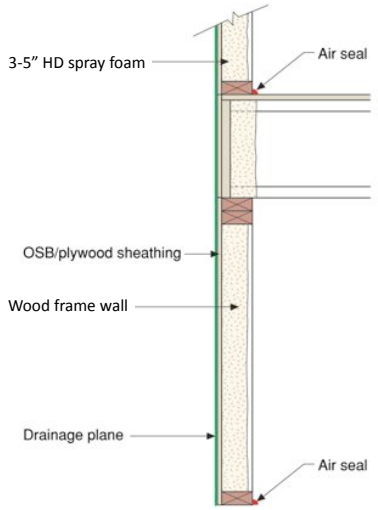
- Need to support or adhered membranes
  - Eg Poly and Tyvek

Two air barriers?

- One good one to stop airflow across the enclosure
- One to stop loops from inside or outside
  - Air impermeable foams

Spray foam

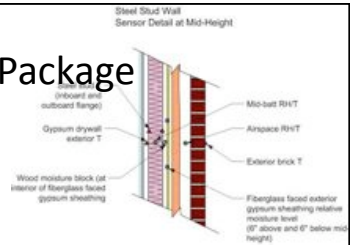
- Growing demand for SPF
  - Want more R-values
  - Want better airtightness
  - Deal with complex geometry
- Questions
  - What about vapour control?

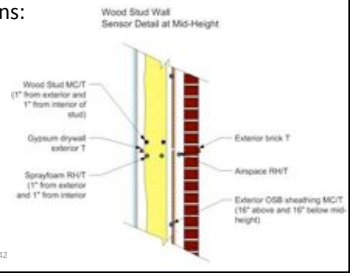


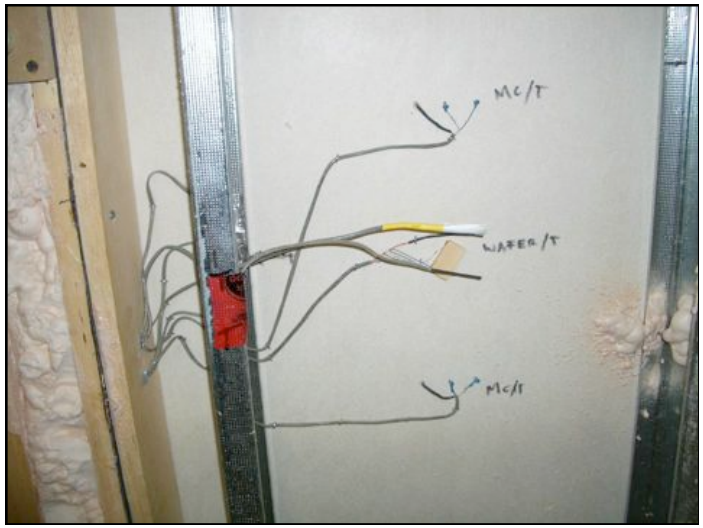
The Beghut

Sensor Package

- Within walls
  - Temp, RH, MC
  - Two OSB MC
- Interior and Weather conditions:
  - Temp, RH, sun, rain, wind,
- Every 5 minutes, saved hourly

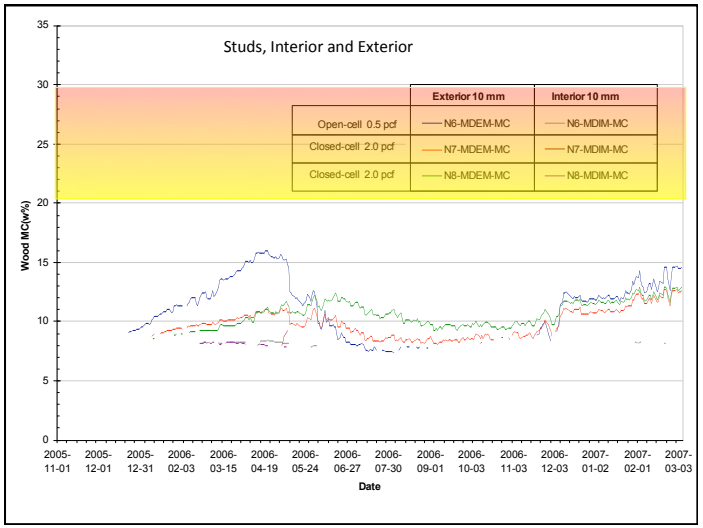






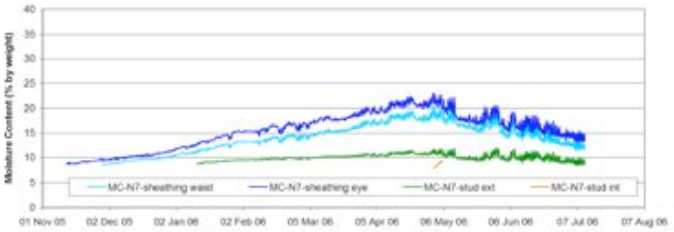
Environmental Conditions

- Interior
  - Warm (21 C) and very humid (50%)
- Exterior
  - Cool 4500 DD, design temp -21 C
- Computer modeling allows us to *extrapolate* to other conditions – colder, warmer, drier



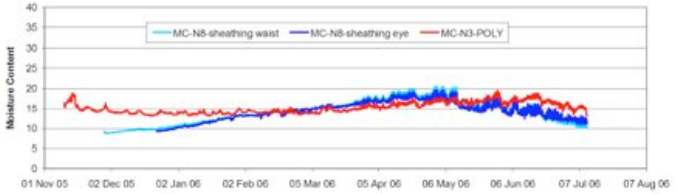
Closed Cell Foam

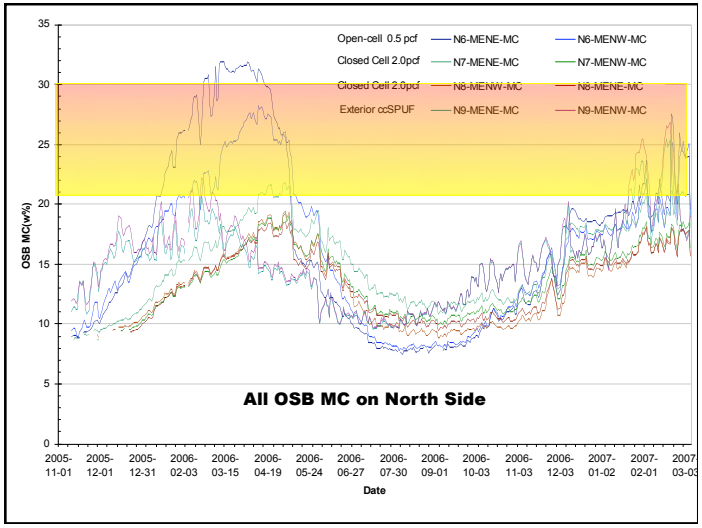
- Still safe with 50%RH inside and north face



Closed-cell SPUF vs poly FG

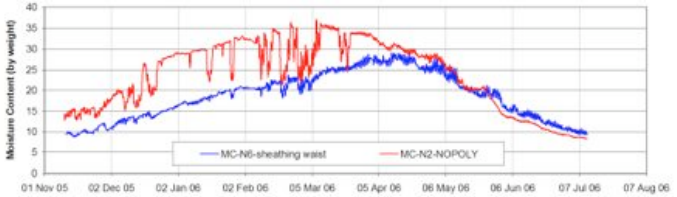
- Sheathing MC about the same (assuming airtight!)
- BUT, summer condensation occurs in the poly wall if A/C and brick





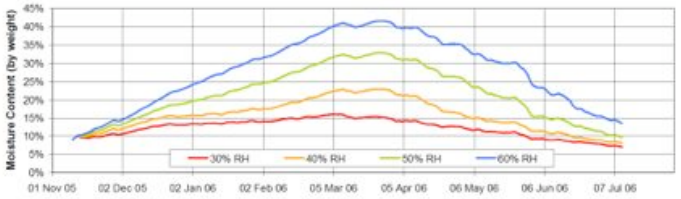
Comparisons to Other Walls

- Open cell foam controls better than fibreglass w/ just latex paint



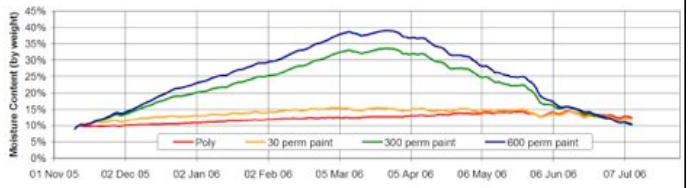
Open cell foam

- Exterior Conditions: Toronto, North side
- Interior Conditions: vary from 30-60%RH



Vapor Control Layers

- Open Cell Foam
- North-facing, Toronto 21 C/50%RH
- Poly, vapor-control paint, open latex paint



Field Results

- Polyethylene not needed in most cases
- 2 pcf closed cell foam controls vapor flow even in challenging conditions
  - If RH >50% and colder than 4000 HDD recommend exterior foam or vapor permeable (DensGlas)
  - E.g. Swimming pool in Edmonton
- ½ pcf foam requires vapor control in cold climates
  - in conditions (>40% and 4000 HDD) recommend vapor control paint layer, Smart vapor retarder