



National Institute of Building Sciences Provider #G168

BEST4 Conference
Nibsbest4 • April 13-15, 2015

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Learning Objectives

Participants will :



1. Learn about the risks associated with high-R or superinsulated walls, relative to conventional/code construction?
2. Understand some of the options for constructing high-R walls in cold climates?
3. Learn about moisture conditions and resulting damage are seen at double stud wall sheathing after experiencing high interior humidity conditions?
4. Understand the effect vapor permeance can have on cold-climate wall performance



Kohta Ueno

Field Monitoring for Cold-Climate Double Stud Walls with Cellulose and Low Density Foam Insulation

BEST Conference Building Enclosure Science & Technology
April 15, 2015

Building Enclosure Science & Technology

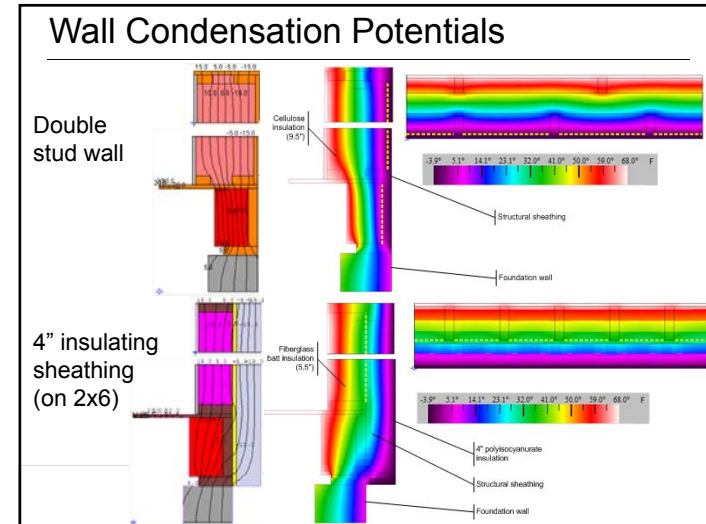
Background

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Double Stud Wall Monitoring

- Double stud wall advantages:
 - High R values
 - Simplifies exterior detailing (few changes to standard practice)
 - Lower cost vs. other high-R walls?
- Moisture risks due to interstitial condensation?
 - Most common failure, after rain control issues
 - Air barrier imperfections—increase risk
 - Air permeable low-density insulations—increase risk
 - Air impermeable insulations (foams)—decrease risk
 - Reduce risk with “skim” of spray foam at sheathing?

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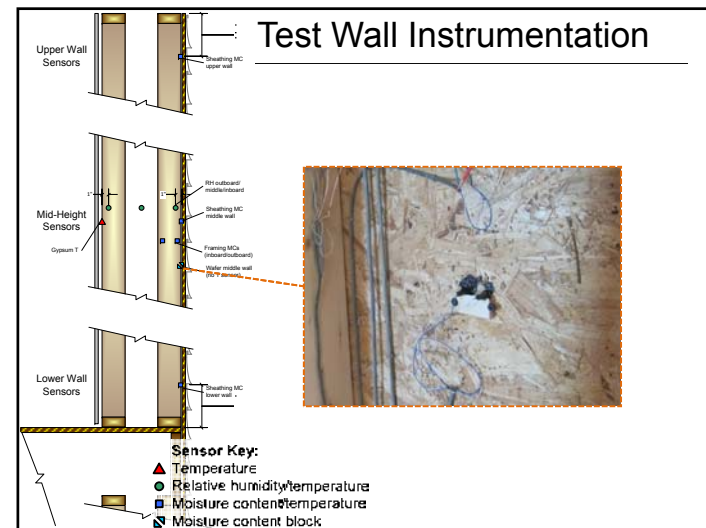
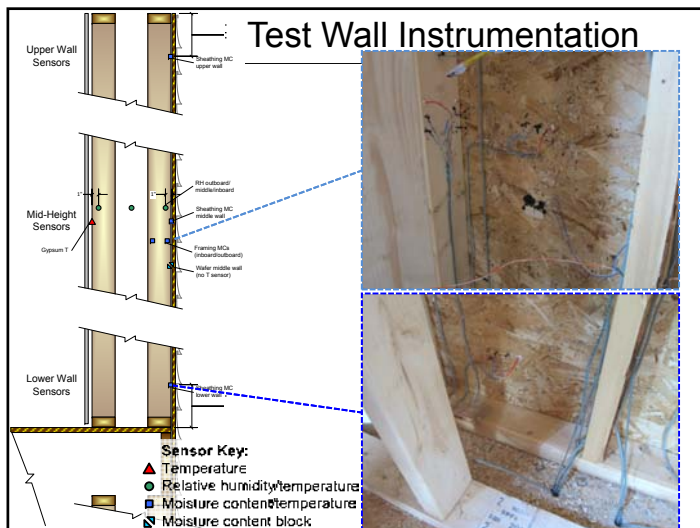
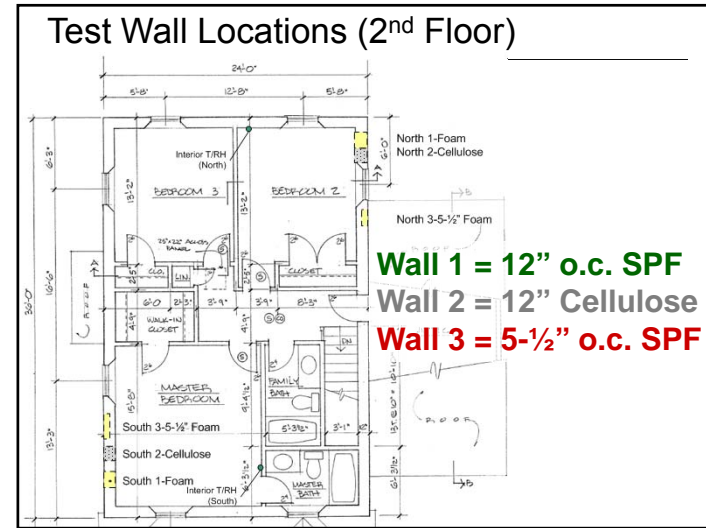
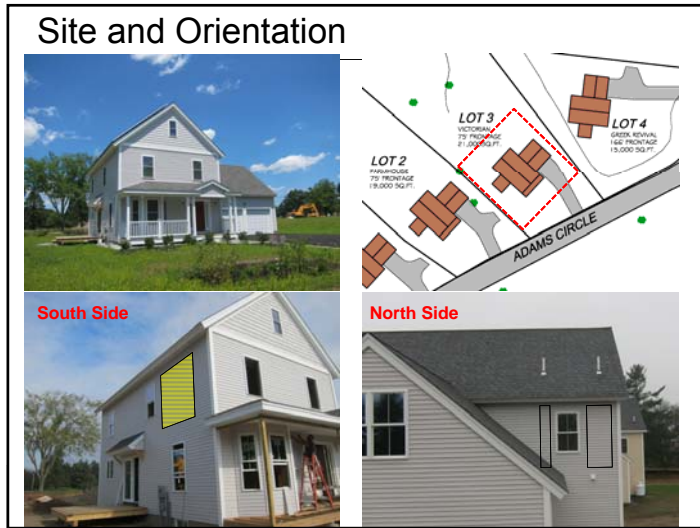


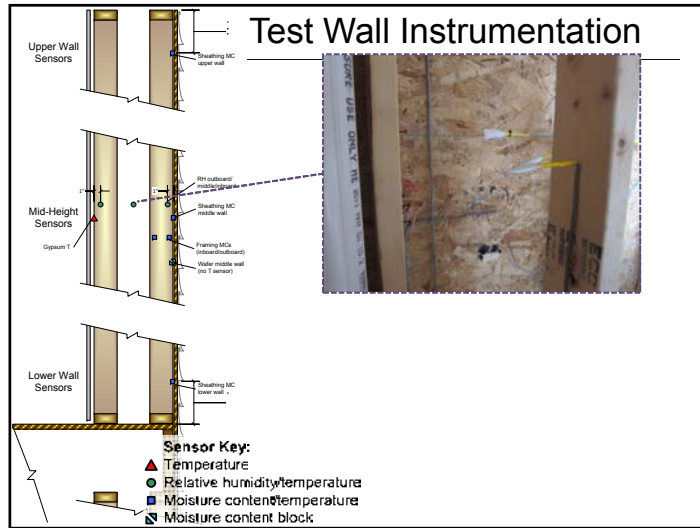
Experimental Setup

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Wall Construction

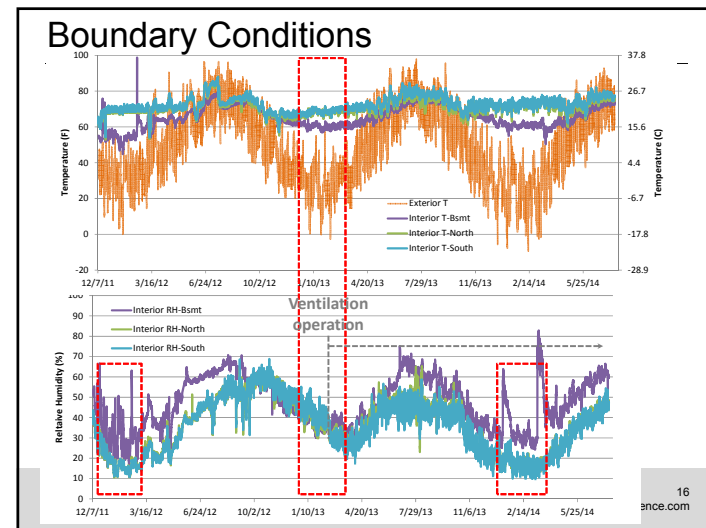
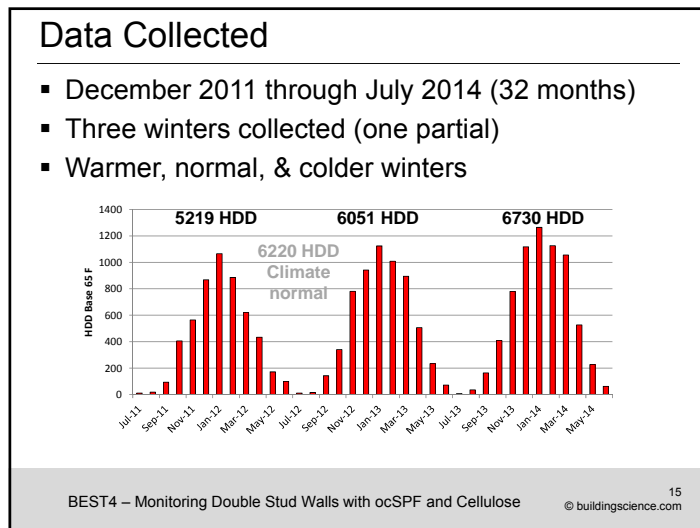
- Vinyl siding
- ZIP wall sheathing (OSB)
- Class III vapor control (latex paint)
- IRC R601.3.1—vented cladding over OSB





Results: Boundary Conditions

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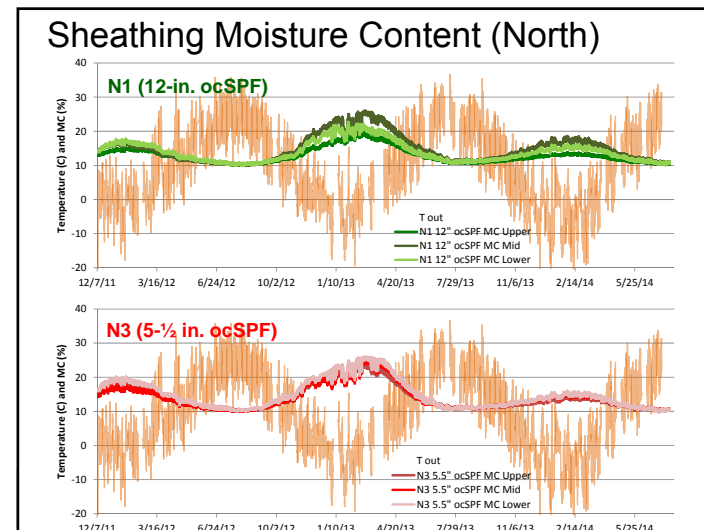
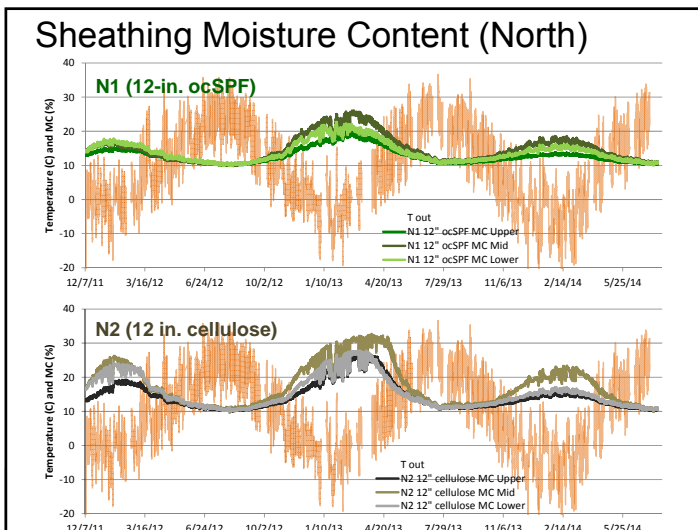
Boundary Conditions Takeaways

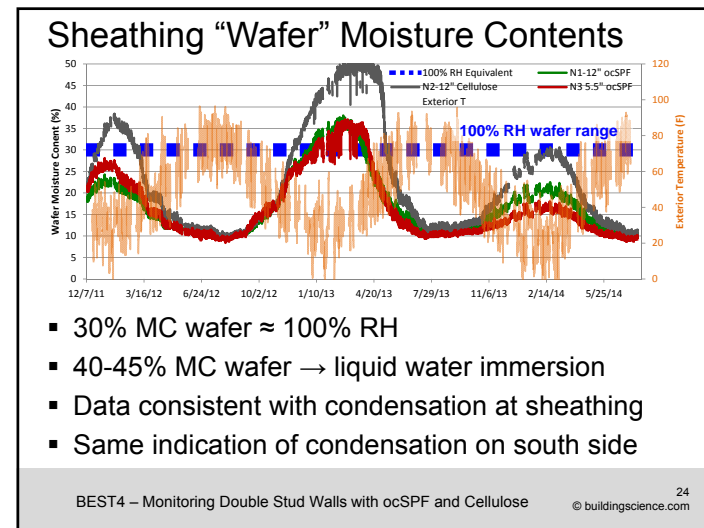
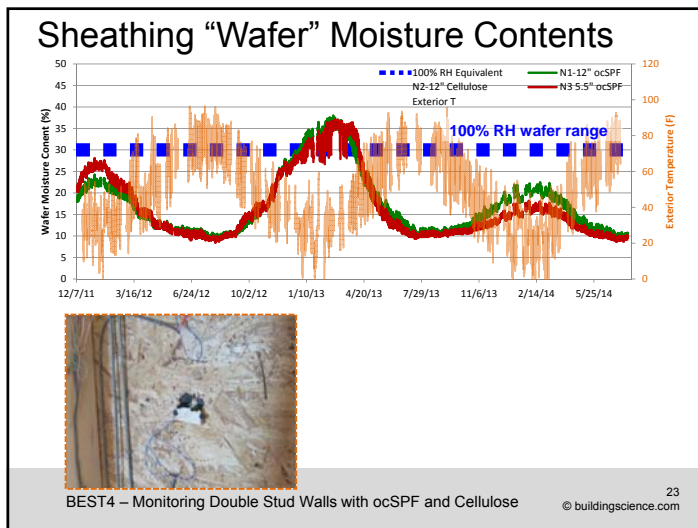
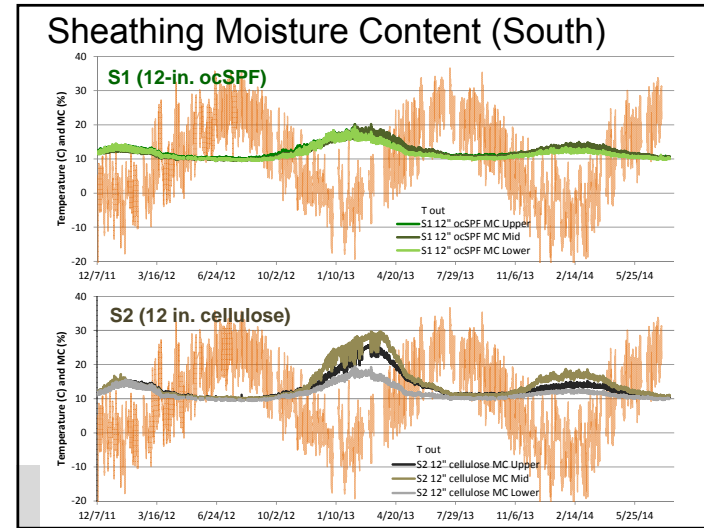
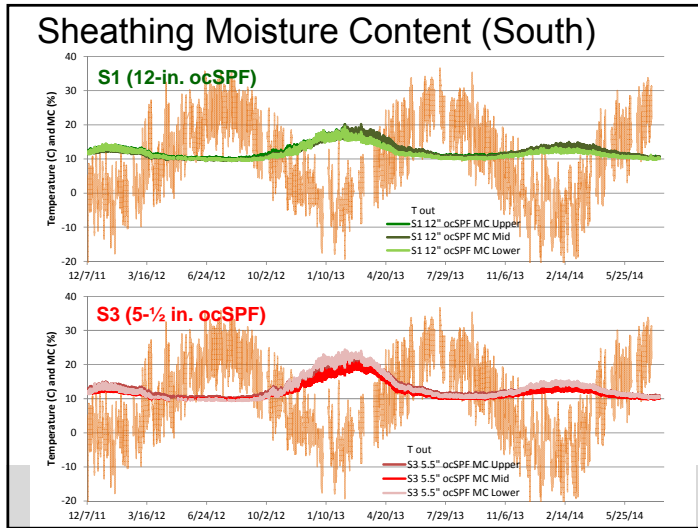
- First Winter (Partial)
 - Unoccupied conditions (no occupant moisture generation)
 - **Very low interior RH**
 - 5220 HDD Base 65 vs. 6220 HDD “normal”
- Second Winter
 - Occupied family of four (2 adults, 2 children)
 - Ventilation system not running, ~1 ACH 50 → **High RHs**
- Third Winter
 - Winter of the “polar vortex”
 - Occupied conditions (same family)
 - Ventilation system running → **RHs ~15-30%**

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Results: Wall Monitoring

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Wall Disassembly

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South Side Disassembly



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South Side Disassembly

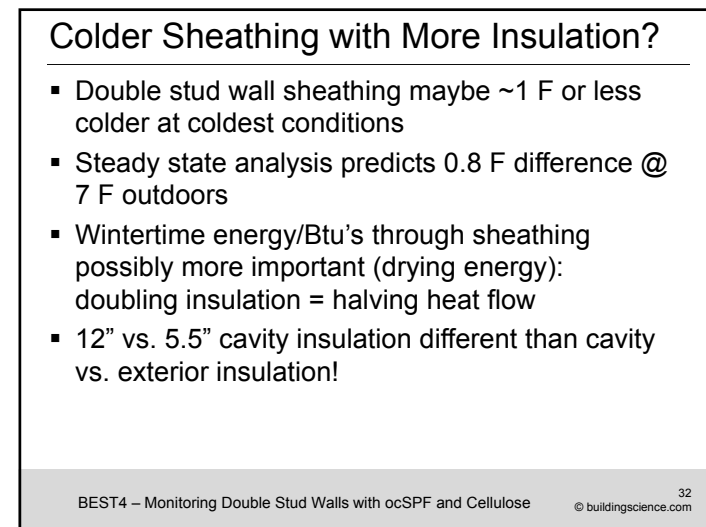
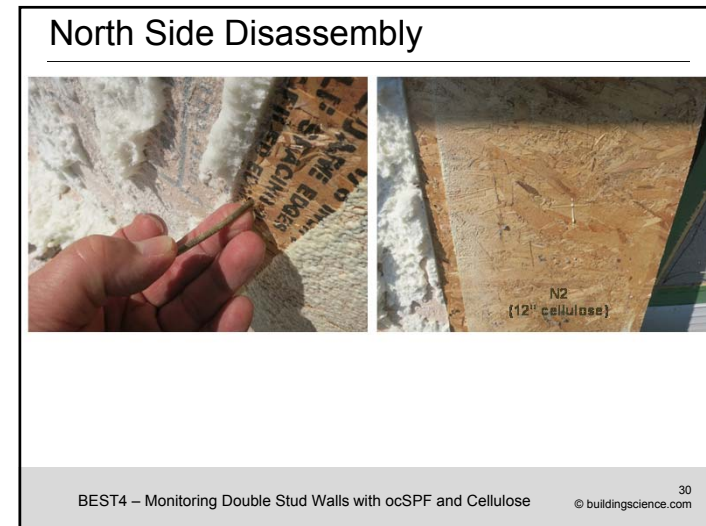
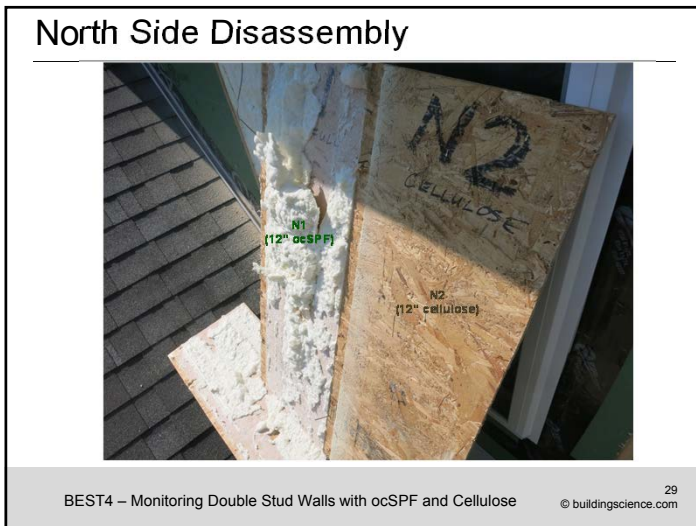


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North Side Disassembly



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Vapor Permeance of Insulation Layer

Wall ID	Insulation Material	Vapor Permeability (Insulation Only)	Vapor Permeability (Add 10 Perm Class III Vapor Retarder)
N1/S1	12 in. 0.5 PCF foam	1.8–2.5 perms	1.5–2.0 perms
N2/S2	12 in. cellulose	7.0–10 perms	4.0–5.0 perms
N3/S3	5-½ in. 0.5 PCF foam	4.0–5.5 perms	2.9–3.5 perms

- Insulation-only, vs. adding 10 perm Class III vapor retarder (latex paint)
- 12" of ocSPF (brand used here) provides reasonable interior vapor control

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Why Aren't The Walls Wrecked?

- 20% MC or lower—decay fungi inhibited
- Best growth 25-30% MC range
- All walls had MCs over 20% in winter 2; cellulose 30%+
- Condensation indicated—liquid water more important for mold/decay than RH alone

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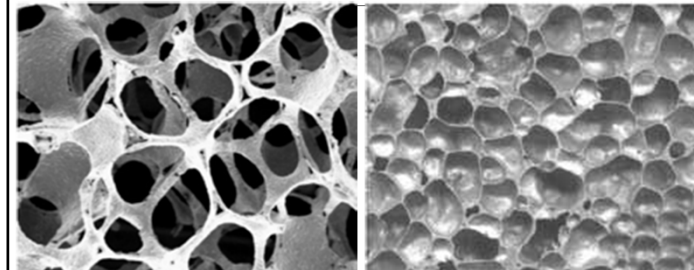
Protective Mechanisms

- OSB Sheathing—all MDI adhesive
- Cellulose fiber insulation
 - Borate preservative/fire retardant—also leaches into adjacent materials
 - Moisture storage in cellulose
 - Airflow retarding qualities
- Open cell polyurethane spray foam
 - Oxygen restriction?

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ocSPF Protective Mechanisms



Open-cell SPF

Images c/o SPFA

Closed-cell SPF

- Food science literature—oxygen needs to be in PPM range before inhibiting mold growth. Mold can get oxygen from substrate.

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Protective Mechanisms

- OSB Sheathing—all MDI adhesive (no PF)
- Cellulose fiber insulation
 - Borate preservative/fire retardant—also leaches into adjacent materials
 - Moisture storage in cellulose
 - Airflow retarding qualities
- Open cell polyurethane spray foam
 - Oxygen restriction?
 - “Flash heating”? Hot enough long enough?
 - Surface treatment (film formation)?
 - Capillary redistribution (through ocSPF pores)?

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Conclusions

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Monitoring Conclusions

- “Normal” interior RH conditions:
 - ocSPF walls stayed below 20% MC—**SAFE**
 - Cellulose > 20% MC on north—**WORRYING, BUT...**
- High interior RH conditions
 - ocSPF walls peaked in 18-25% MC range
 - Cellulose >30% MC, condensation indicated
- Each summer, walls dried to safe conditions
- ASHRAE 160 and mold isopleths say these walls have failed
- Disassembly showed all walls look okay
 - Sheathing reinstalled

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Construction Recommendations

- Based on Zone 5A Climate
- Cellulose walls
 - Class III (latex paint) risky
 - Class II (VR paint, variable-permeability membrane safer)
 - Class I (polyethylene) NOT recommended
- ocSPF walls
 - ocSPF seems to provide sufficient vapor control
 - Class II possible option on conservative side
- Mechanical ventilation system vital
- Exterior insulated walls much more moisture-safe!

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Questions?

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This presentation will be available at:

<http://www.buildingscienceconsulting.com/presentations/recent.aspx?PresentationsYear=2015>

The full Building America report on this research:

<http://www.buildingscience.com/documents/bareports/ba-1501-monitor-double-stud-moisture-conditions-northeast/view>



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