

## 2014 BCBEC Conference & AGM

### Building Performance ...The Way Ahead

Fairmont Hotel Vancouver

# “Wetting and Drying of Exterior Insulated Walls”

September 24, 2014

Mark Gauvin <sub>1</sub>

## The Coquitlam Test Hut

### A Building Enclosure Research Facility

Located at:  
1140 Austin Avenue  
Coquitlam, B.C.

## Introduction

Mark Gauvin, President  
Gauvin 2000 Construction Ltd.  
**General Contractor**

- ▶ Now 41 years in business
- ▶ About 5400 residential units
- ▶ Retail, office, institutional buildings
- ▶ Renovations and restorations

3

## Building Science



Dr. John Straube, PhD



Dr. Joseph Lstiburek, PhD

May 17, 2004 First Discussion of Test Hut

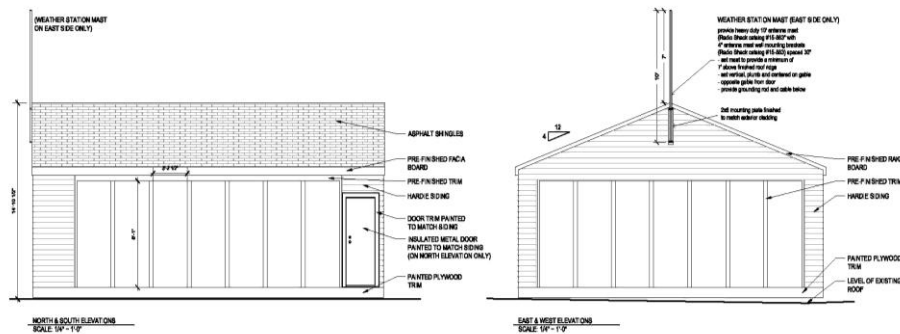
4

## An Informal Partnership

- Gauvin 2000 Construction Ltd.
  - Construction and Maintenance
- Building Science Corporation
  - Expertise, Guidance, Analysis
- Balanced Solutions Inc. (now Building Science Labs)
  - Instrumentation, Monitoring, Analysis
- And some “hands off” Funding & Materials
  - from various Manufacturers and Suppliers

5

Plans – 2 weeks...  
Permits – 1 year



Phoenix Structural Designs Ltd.  
Port Coquitlam, B.C.

6

## Construction Underway



October, 2005

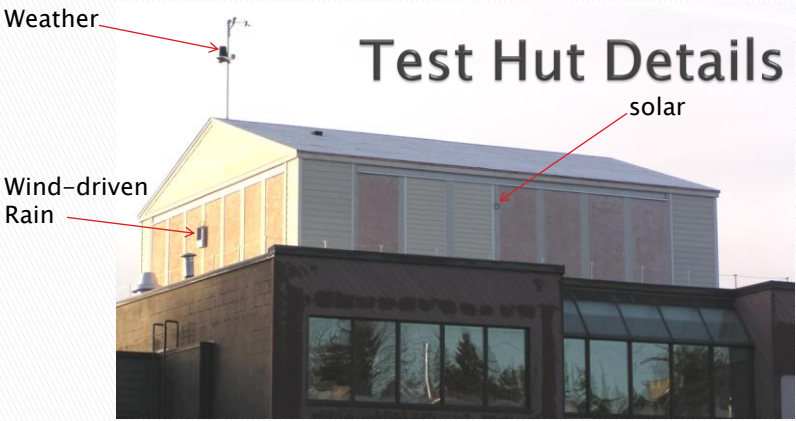
7

## Test Panel Openings



8

## Test Hut Details

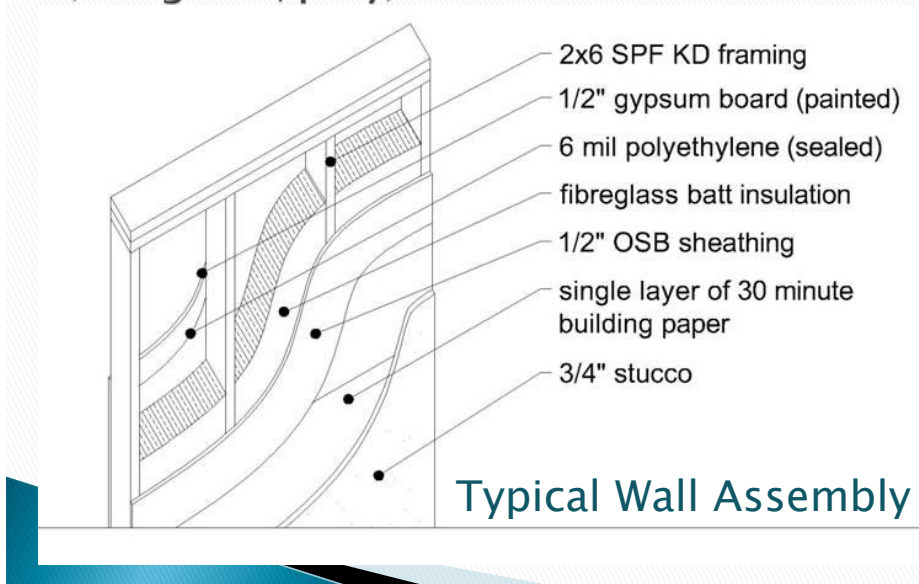


- ▶ 7 Wall assemblies each orientation (x4)
- ▶ 3 Roof assemblies each orientation (x2)
- ▶ Full weather station

Phase 1 testing begins November, 2005

9

### 1980s Energy Efficient 2x6 (airtight w/poly)



## Wall Assemblies (Phase 1, 2, 3)

70's	90's	90's	USA	Rain/Screen	Foam	
<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>
2x4	2x6	2x6	2x6	2x6	2x6	2x6
paper	Poly	Paint	Paint	Poly	Paint	Paint
R8	R20	R20	R20	R20	R20	R20+5
3/8 ply	½ OSB	½ OSB	½ OSB	½ OSB	½ OSB	*½ OSB
1 paper	1 paper	1 paper	Drain-wrap™	House wrap™	House wrap™	Drain-wrap™
Stucco	Stucco	Stucco	Stucco	*Stucco	*Stucco	Stucco

\* Variation on N. & S. Walls

11

## Instrumentation

### Sensors – Walls and Roof

- Temperature
- Relative Humidity
- Wood moisture content – EMC

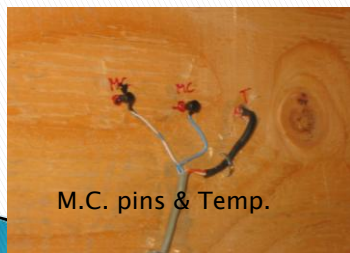
### Located:

- Bottom and mid-height each wall
- Inside, middle, outside each wall
- Upper interior face of sheathing (Phase 3, 4)

12

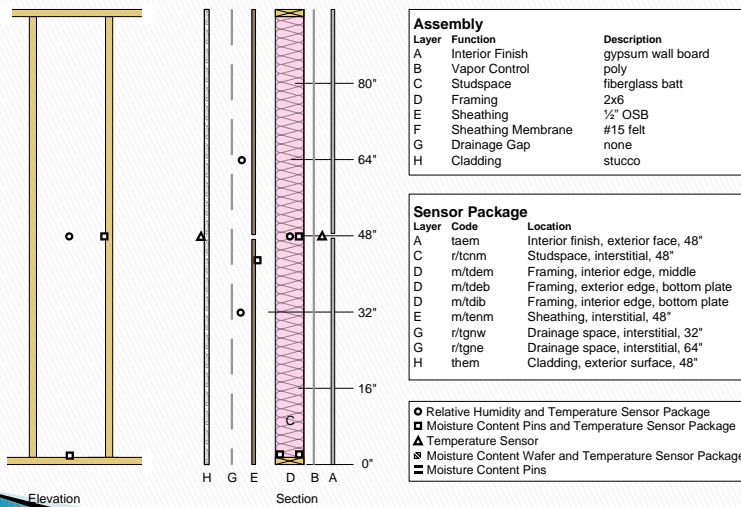


# Sensors & Wetting Systems



13

# Typical Sensor Layout



14

## Data Collection



Design by Chris Schumacher, Bldg Science Labs

15

## Phase 1, 2, 3 Testing

### Short summary:

- ▶ Outdoor climate important.
  - Vancouver rain occurs many days each year.
  - Vancouver winter time RH very high.
- ▶ Rainwater penetration not good!
- ▶ Rainscreen walls improve drying.
- ▶ Indoor climate (R.H.) affects sheathing MC.
- ▶ Poly VB protects sheathing, but may inhibit inward drying.
- ▶ Exterior insulated walls driest of all walls.

16



## Phase 4 Testing

- ▶ Started September 23, 2012
- ▶ Will run two years
- ▶ Features common to all walls:
  - HardiePlank lap siding, direct applied.
  - 2x6 framing
  - 7/16" OSB sheathing (Wall 4 = Huber 'Zip" wall)
  - R21 Kraft-faced f/g batt, except
    - (Wall 4 = un-faced)
    - (Wall 5 = R13 un-faced + 2" cc spray foam)
  - ADA drywall w/perimeter gasket seal.
  - Primer + 2 coats latex paint.

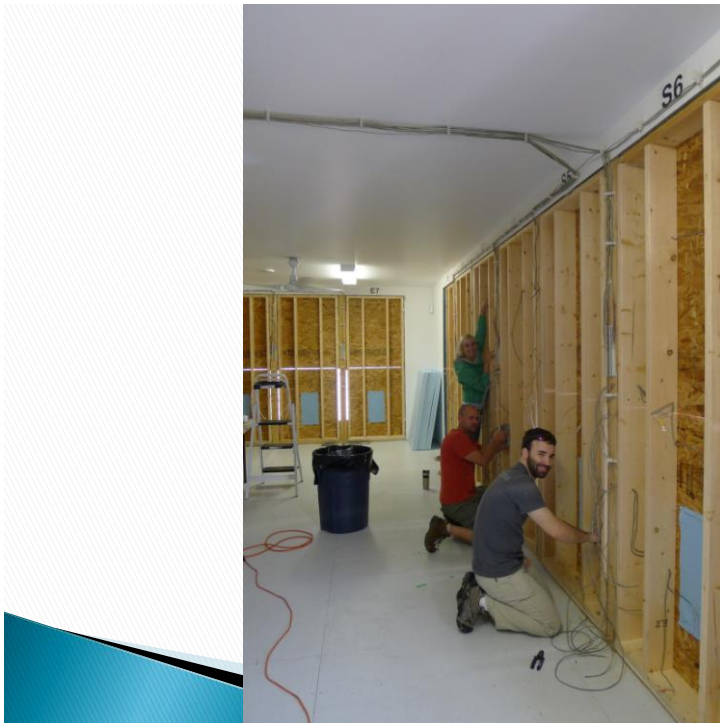
17

## Phase 4 Testing

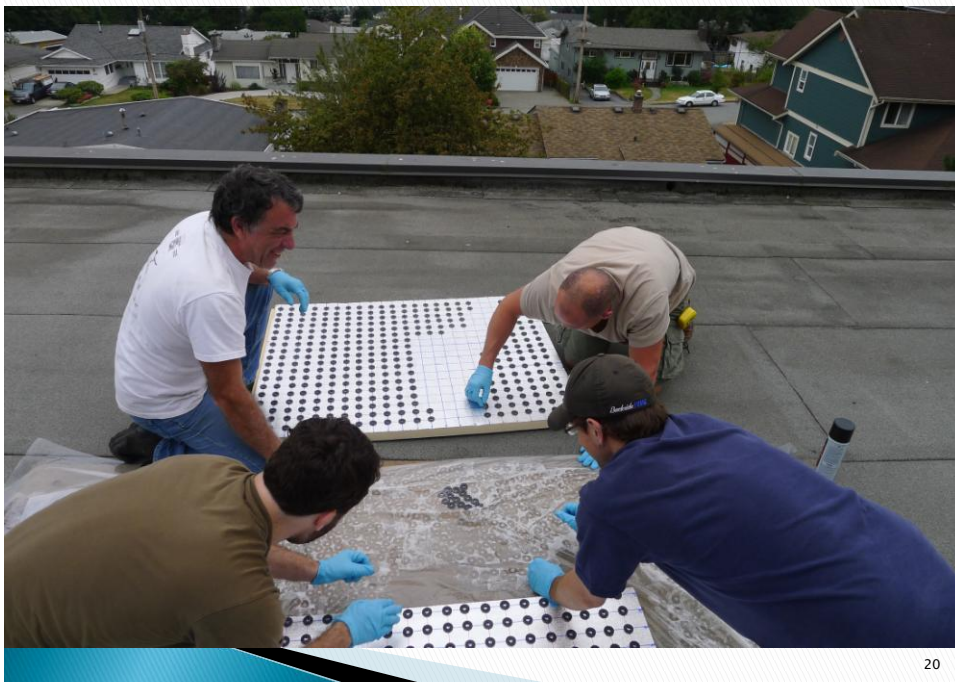
### Variations to exterior sheathing:

- ▶ **Wall 1:** CONTROL – no exterior insulation.
- ▶ **Wall 2:** 1½" XPS foam, taped joints.
- ▶ **Wall 3:** 1½" XPS foam, taped, DrainWrap®.
- ▶ **Wall 4:** 1½" XPS foam, taped, Huber Zip®,.
- ▶ **Wall 5:** 1½" f.f. polyiso, with ⅛" drainspace
  - and 2" closed cell sprayfoam to interior face
- ▶ **Wall 6:** 1½" f.f. polyiso, taped joints.
- ▶ **Wall 7:** 1½" f.f. polyiso, taped, ⅛" drainspace.

18



19



20



North Elevation (Austin Ave.)

21



22

## Where does the water come from?

- ▶ Water Vapour – Relative Humidity
  - Indoor RH Environment
  - Outdoor Weather RH Environment
  
- ▶ Condensation
  - Indoor RH Environment (diffusion)
  - Indoor RH Environment (air leakage)
  - Outdoor Environment (dew –night sky cooling)
  
- ▶ Liquid Water
  - Indoor – Plumbing Leaks, Floods
  - Outdoor – Rainwater Penetration

23

## A few graphs:

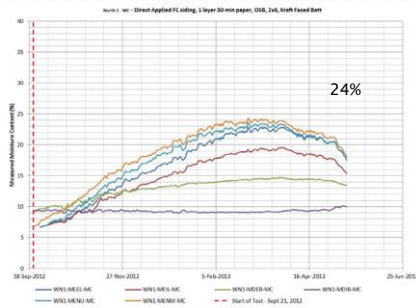
First 8 months, no water added

Response to ambient conditions:

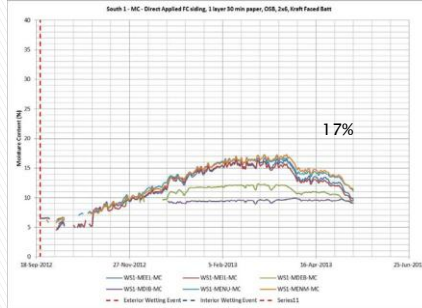
- Outdoor climate
- Orientation
- Indoor climate

24

## OSB Sheathing Moisture Content Phase 4 – Indoor at 50% RH, 21° C.



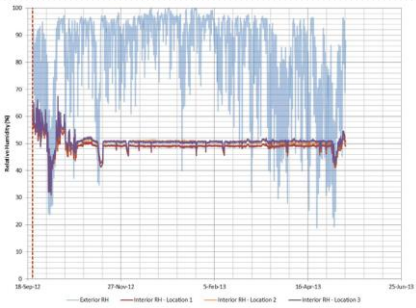
Wall 1 – North  
Control (no exterior insulation)



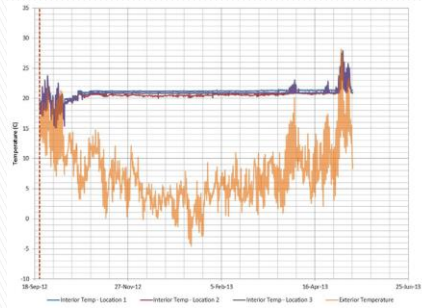
Wall 1 – South  
Control (no exterior insulation)

25

## The Environment



Interior RH at 50%  
Ambient RH (blue)



Interior Temp. at 21° C.  
Ambient Temp. (orange)

26



## More graphs:

First 8 months, no water added

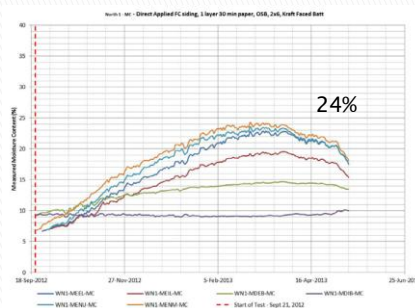
Compare:

- ▶ Wall 1 Control Wall, and
- ▶ Wall 2 with 1½” XPS exterior foam and,
- ▶ Wall 6 with 1½” foil faced polyiso foam.

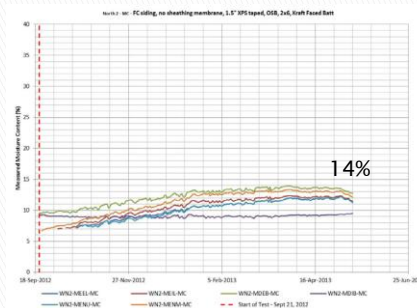


27

## OSB Sheathing Moisture Content Phase 4 – Indoor at 50% RH, 21° C.



Wall 1 North  
Control (no exterior insulation)

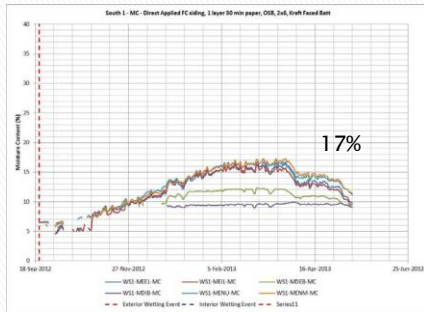


Wall 2 North  
1½” XPS Foam to exterior

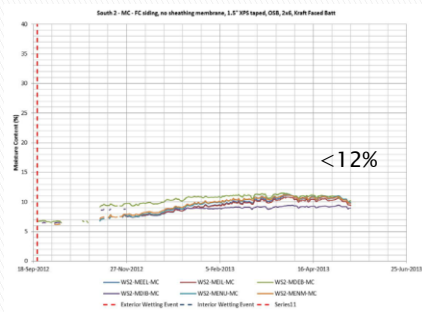
28



## OSB Sheathing Moisture Content Phase 4 – Indoor at 50% RH, 21° C.



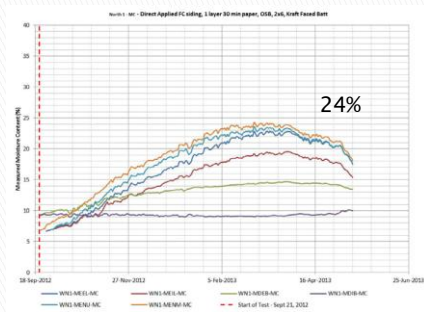
Wall 1 South  
Control (no exterior insulation)



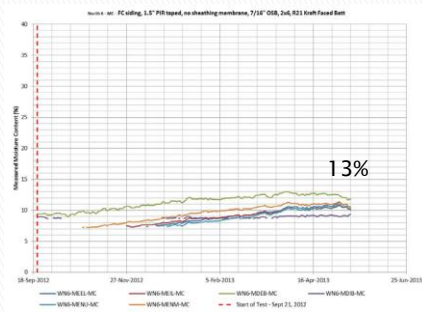
Wall 2 South  
1 1/2" XPS Foam to exterior

29

## OSB Sheathing Moisture Content Phase 4 – Indoor at 50% RH, 21° C.

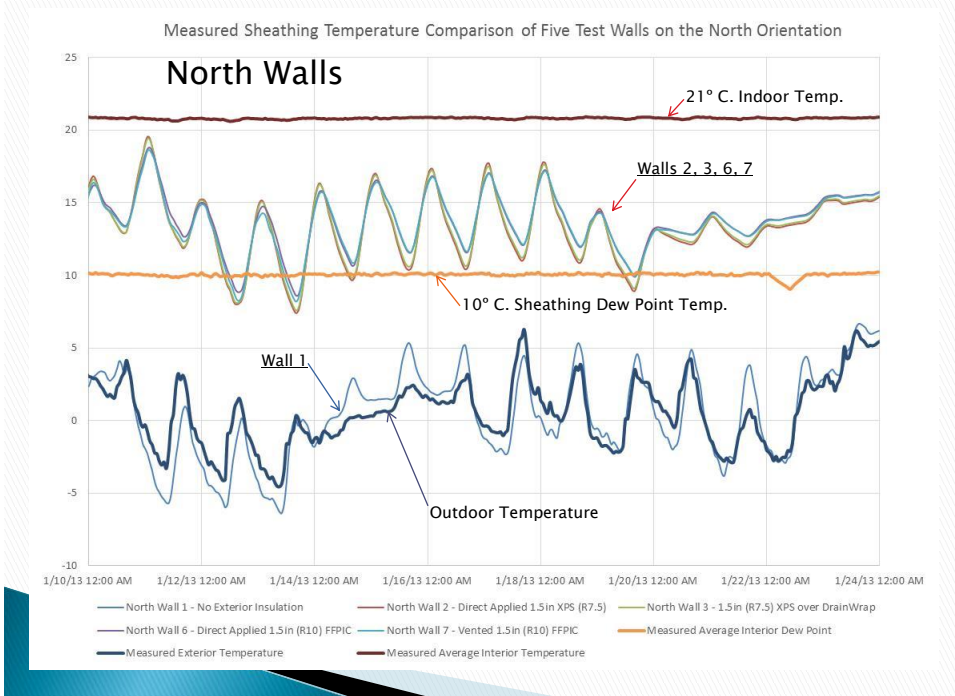
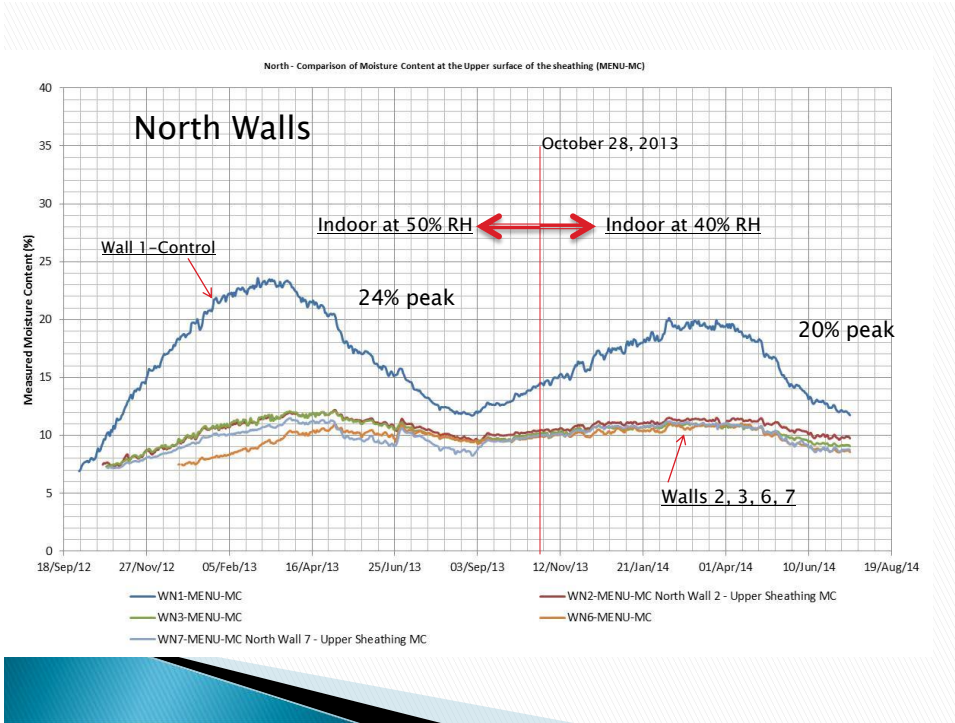


Wall 1 North  
Control (no exterior insulation)

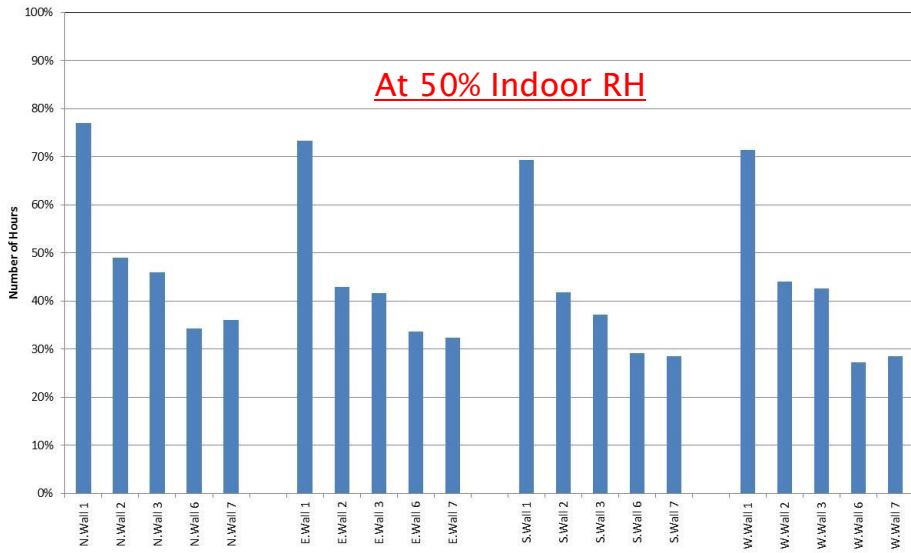


Wall 6 North  
1 1/2" F.F. Polyiso Foam to exterior

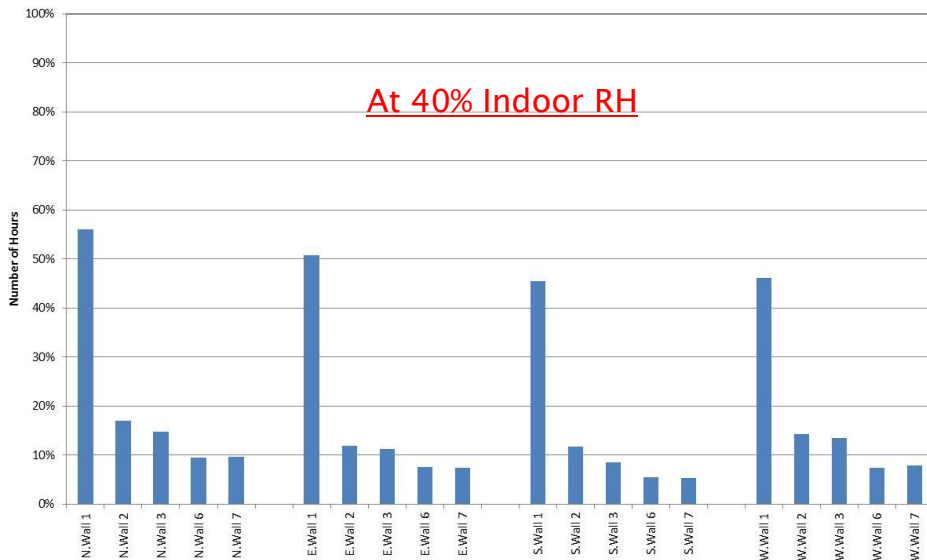
30



**Potential Air Leakage Condensation Oct 1, 2012 - May 1, 2013 - 5087 hours**  
 (measured sheathing temperature and measured interior dew point, 50% interior RH)



**Potential Air Leakage Condensation Oct 1, 2013 - May 1, 2014 - 5087 hours**  
 (measured sheathing temperature and measured interior dew point, 40% interior RH)



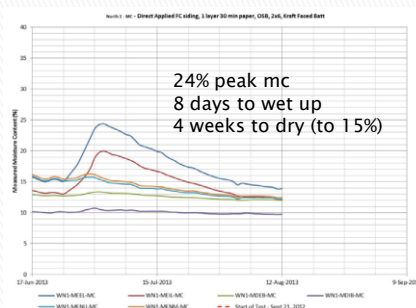
## What happens when water is added to OSB sheathing (rainwater penetration) ?

- ▶ 1<sup>st</sup> wetting: June 24–28, 2013
- ▶ 2<sup>nd</sup> wetting: Sept. 2–13, 2013
- ▶ 3<sup>rd</sup> wetting: Nov. 20–24, 2013 (interior side)
- ▶ 4<sup>th</sup> wetting: Mar. 25–29, 2014
- ▶ 5<sup>th</sup> wetting: July 21–25, 2014

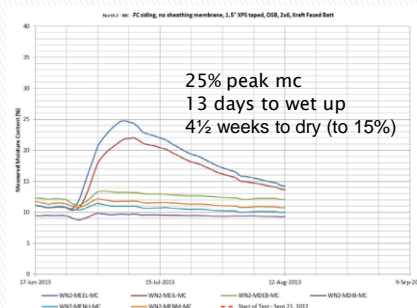
35

### 1<sup>st</sup> Wetting June 24, 2013

1½ oz. water twice per day x 5 days



Wall 1 North  
Control (no exterior insulation)

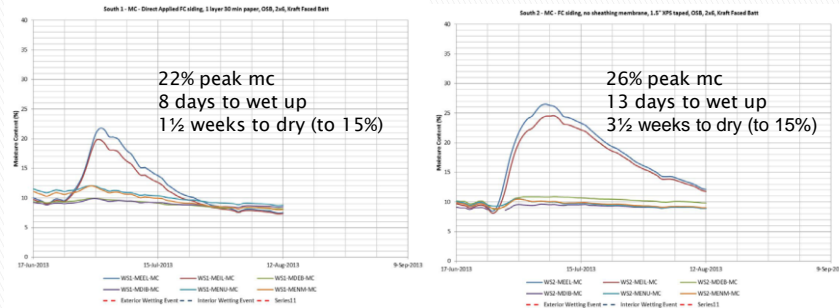


Wall 2 North  
1½" XPS foam to exterior

36

# 1<sup>st</sup> Wetting June 24, 2013

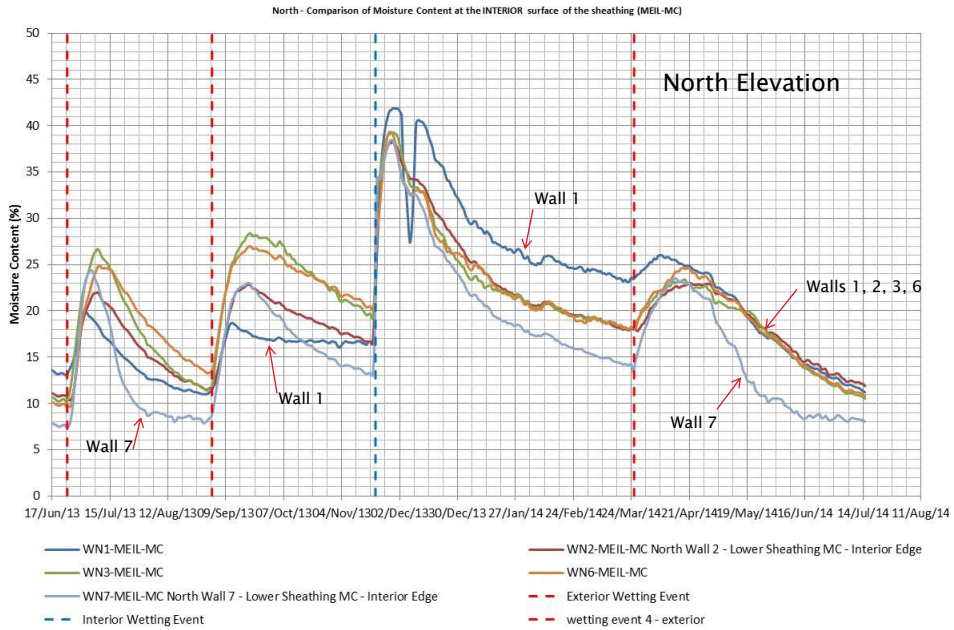
## 1 1/2 oz. water twice per day x 5 days



**Wall 1 South**  
Control (no exterior insulation)

**Wall 2 South**  
1 1/2" XPS foam to exterior

37



## Some comments:

- ▶ Drying is slow in all wall assemblies – with or without exterior insulation.
- ▶ Rainwater management is critical for all assemblies.
- ▶ Interior/Exterior RH cause wetting.
- ▶ Control indoor RH – ventilation is important.
- ▶ By raising sheathing temperature – exterior insulation helps:
  - to reduce running moisture content.
  - to reduce condensation potential.

39

## More information at...

Building Science Laboratories

<http://www.buildingsciencelabs.com/project/the-vancouver-test-hut/>

Moisture-Related Durability of Walls with Exterior Insulation in the Pacific Northwest

[http://www.buildingsciencelabs.com/consulting/wpc-ontent/uploads/2014/02/211\\_Smegal.pdf](http://www.buildingsciencelabs.com/consulting/wpc-ontent/uploads/2014/02/211_Smegal.pdf)

ASHRAE Buildings XII, Clearwater, Fl.  
(powerpoint)

<http://sites.buildingsciencelabs.com/presentations/>

40