

Kohta Ueno

## NESEA BE12: From Past to Future: The Green Mill Renovation




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### Learning Objectives

- Summarize major green characteristics of mill redevelopment
- Explain interior retrofit insulation concerns and strategies
- Describe ventilation constraints, objectives, solutions for multifamily
- Implement unit compartmentalization strategies



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### Overview: Inside or Outside Insulation?

- Insulating on exterior always preferable (masonry durability, condensation risks)
- Interior insulation → historic preservation reasons
- Interior → potential durability risks
- Energy efficiency, preserve exterior, museum-level durability: choose 2 of 3





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### Cold Climate Risks

1. Freeze-thaw (reduced drying)
2. Air leakage condensation on interior face of masonry
3. Rot / corrosion of embedded elements

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### Cold Climate Risks: Condensation

- Requires perfect workmanship at air barrier—around penetrations, etc.
- Made worse by air gap behind insulation
- NOT RECOMMENDED**

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### Embedded Wood Member Risks

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### The Moisture Balance

- Large storage capacity (mass wall)
- Drying decreases with insulation
- Design should reduce/control wetting to compensate

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### Windows (Potential Rain Entry Point)

Labels in diagram: Liquid applied membrane waterproofing, Flanged window, Trim closure, Concrete sill, Approx. 4" overhang, 4 wythe masonry wall, Air seal, 1 1/2" extruded polystyrene rigid insulation (XPS), Plywood spacer, 1x2 backdam, 2" spray applied foam insulation (closed cell, high density), Uninsulated steel stud assembly, Gypsum board.

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### Windows (Water Concentration)

Labels in diagram: Sill pan flashing, note backdam to prevent inward water movement; overlaps and drains onto surface of sill; pan flashing should extend min. 4" up jamb vertically. Caulk and backer rod joint, to avoid entry of water into masonry wythes. Regletted flashing/drip edge: can be wedged in place instead of mechanical fastening, if acceptable. Alternate: improves drainage but is more visible; have drip edge fall from outside edge of sill.

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### Water Concentrations

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### Do We Need to Insulate Mass Walls?

Climate: Burlington, VT

Case 1: Uninsulated Masonry (~R-5)

Month	Heat Flux In (W/m²)	Heat Flux Out (W/m²)
October	0	-10000
November	0	-12000
December	0	-14000
January	0	-16000
February	0	-18000
March	0	-15000
April	0	-10000
May	0	-5000
June	0	-2000
July	0	-1000
August	0	-5000
September	0	-10000

Case 2: 1.5" ccSPF Foam (~R-5+R-8.7)

Month	Heat Flux In (W/m²)	Heat Flux Out (W/m²)
October	0	-5000
November	0	-6000
December	0	-7000
January	0	-8000
February	0	-9000
March	0	-7000
April	0	-4000
May	0	-2000
June	0	-1000
July	0	-500
August	0	-2000
September	0	-5000

Case 3: 3" ccSPF Foam (~R-5+R-17.3)

Month	Heat Flux In (W/m²)	Heat Flux Out (W/m²)
October	0	-2000
November	0	-2500
December	0	-3000
January	0	-3500
February	0	-4000
March	0	-3000
April	0	-1500
May	0	-800
June	0	-400
July	0	-200
August	0	-500
September	0	-1500

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### Recommended Approaches

- Spray foam against masonry
- Open cell (0.5 PCF)? Closed cell (2.0 PCF)? Intermediate (1.0 PCF)?
- Condensation risks within beam pocket: air seal

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### Hybrid Wall Insulation Assembly

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### Tapered Window Openings

Minimum ~R-5 for thermal comfort (radiant surface temperatures)

Leverage spray foam for air barrier continuity to window opening

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### Thermal Bridging at Slab Floors

Outdoor air supplied and heated to near indoor temperature during cold weather (very low RH). Pressure controlled to 2-4 Pa above indoor pressure in each zone.

Vapor permeable, low density spray foam air barrier insulation

Dry, warm air leaks to the interior through unintentional openings/cracks

Interior humidity conditions controlled to prevent condensation on thermal bridges (e.g. slabs)

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### Thermal Bridging at Slab Floors

45.7°F  
ε=0.90  
FLIR

41 52

R-20 for 10 foot wall  
R-3 for 1 foot floor slab  
R-13 overall R value

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### Interior Brick Exposed to Exterior

Reference: Canadian Building Digests 138:  
On Using Old Bricks in New Buildings

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### Hygrothermal Simulations

Volume considered for predicting Freeze-Thaw of Grey Face Brick

Volume considered for predicting Freeze-Thaw of Exterior Wythe of Red Fill Brick

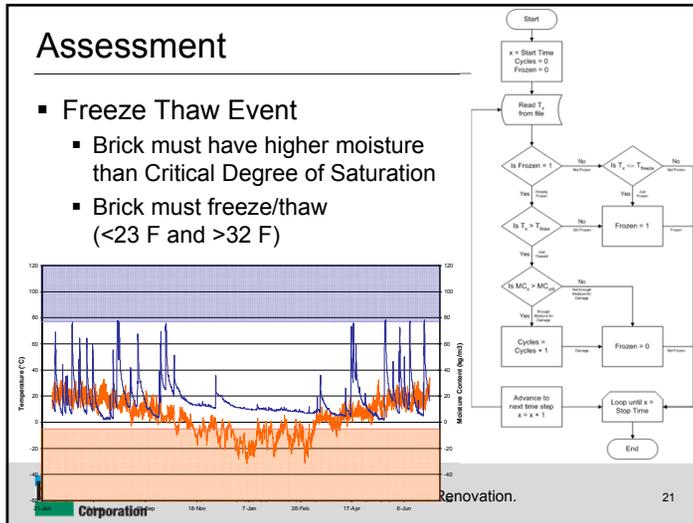
Volume considered for predicting Freeze-Thaw of Exterior Face of Clay Tile

Exterior Interior

24,5 24,5 24,5 24,5 115,0 93,0 12,0 93,0 12,0 93,0 15,17,0 66,0 17 13,0

Thickness [mm]

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### Air Barrier Issues

Can't rely on masonry alone to be an air barrier

13" brick wall, 100 sf = 3.1 sq. in. leakage EqLA

Same with 3 coat plaster = 0.054 sq. in. EqLA

Source: CBD-23. Air Leakage in Buildings

### Window Heat Loss in Context

- Large windows (4' x 8'), high glass %
- Can't change frame profile (historic)
- Aluminum, double, low E:  $U \approx 0.5$  (center of glass U-0.30)
- R-2 holes in R-20 walls

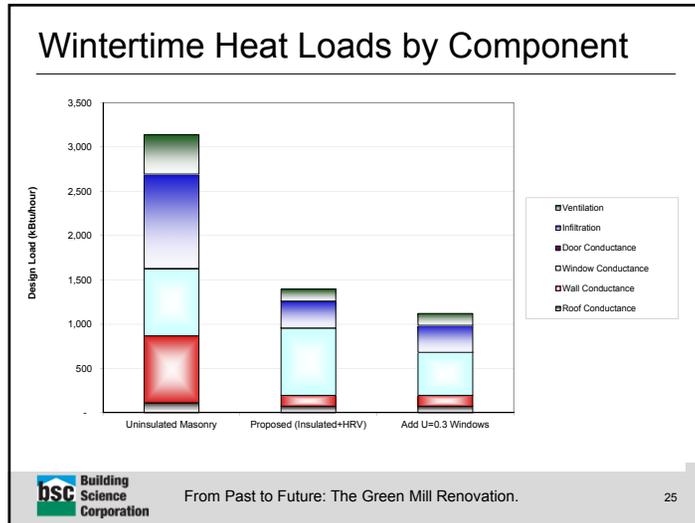
PROPOSED WINDOW  
SCALE: 1/2" = 1'-0" ALUMINUM 1212 OPERABLE

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### Window Heat Loss in Context

- Improved thermal breaks available
- Improved edge spacers available
- Improved center-of-glass (triple, films, etc.)
- All add cost; not typical construction
- Alternate frame materials?

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Thank you for your time!  
 Any Questions?

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