PASSIVE BUILDING CASE STUDIES

NAPHC 2016

PHILADELPHIA, PA / SEPTEMBER 23, 2016

PERKINS+WILL
PHIUS Feasibility Study

• What is it?
  • Preliminary Assessment
  • Preliminary Energy Model
  • Envelope Performance
  • Stepping Stone
GEORGE WEYGAND HALL
BRIDGEWATER STATE UNIVERSITY, BRIDGEWATER, MA
MINIMIZE BUILDING LOADS
1. PRINTER GLASS REDUCES HEAT GAIN AND GLARE
2. HIGH SOLAR REFLECTANCE ROOF MATERIAL REDUCES HEAT GAIN
3. LOW ALBEDO PAINTING MATERIAL REDUCES HEAT GAIN ON SITE
4. CASINGMENT WINDOWS ORIENTED TO SEASONAL BREEZE INTO ROOMS
5. FIBERGLASS WINDOW FRAMES REDUCE THERMAL TRANSMITTANCE
6. CENTRALIZED MECHANICAL SYSTEMS MAXIMIZE CEILING HEIGHT
7. DEEP DAYLIGHT ZONE REDUCES THE NEED FOR ARTIFICIAL LIGHT
8. INCREASED INSULATION TO IMPROVE BUILDING ENVELOPE
9. SUN SHADES OFFER HEAT GAIN PROTECTION
10. GREEN ROOF (PROJECT ALTERNATIVE)

MAXIMIZE ENERGY EFFICIENCIES
11. CONDENSATION EXCHANGE.InSIBIT. HEATING AND COOLING
12. VACUUM SYSTEM - AIR CONDITIONING IN SUMMER
13. VACUUM SYSTEM - HEATING IN WINTER
14. GROVER GLASS HEAT RECOVERY REDUCES ENERGY NEEDED TO HEAT DOMESTIC HOT WATER

UTILIZE ON-SITE ENERGY PRODUCTION
15. ROOF READY FOR RENEWABLE ENERGY PHOTOVOLTAIC PANELS

MINIMIZE BUILDING ENERGY CONSUMPTION
16. ENERGY STAR SUITE-HEATED REFREDDERS IN LIEU OF MINI-FRIDGE REDUCES OVERALL PLUG LOAD
17. NATIVE PLANTINGS REQUIRE NO IRRIGATION
18. PLANTINGS PROVIDE RELIEF TO PAID COURTYARD FOR SOIL MOISTURE ABSORPTION
19. LOCA. LEACH REDUCES ENVIRONMENTAL IMPACT FROM MATERIAL TRANSPORTATION
20. DIRECT ACCESS TO COMMUTER RAIL TO BOSTON
• Geo-exchange Heating & Cooling
• **Valance Suite Heating & Cooling**
• Shower Drain Heat Recovery
• Ventilation Energy Recovery
• Efficient Lighting
• Enhanced Commissioning
AS BUILT
WALLS: R22
ROOF: R48
SLAB: R15
WINDOWS: R3 (INSTALLED)
CURTAINWALL: R1.78 (INSTALLED)

-HEATING DOMINATED
-ASSUMES AIR INFILTRATION
OTHER FACTORS:

BUILDING FORM (SURFACE TO VOLUME)

CURTAIN WALL (LOSS THROUGH ENVELOPE)

THERMAL BRIDGING (MINOR)
MODIFIED TO PH STANDARD
WALLS: R30 (+R8)
ROOF: R48 (SAME)
SLAB: R15 (SAME)
WINDOWS: R5(INSTALLED) (+R2)
CURTAINWALL: R5 (INSTALLED) (+R3.22)

-ASSUMES PH AIRTIGHTNESS
-SHGC FROM 0.27 TO 0.35 ON S. GLASS
(INCREASE SOLAR GAINS)
PARCEL 9

HOTEL AND MARKET, BOSTON, MA
City
Boston

State
MA

Zone
5A

Annual heating demand kBtu/sf·CFA yr
5.3

Annual cooling demand kBtu/sf·CFA yr
2.9

Peak heating load Btu/sf·CFA h
4.4

Peak cooling load Btu/sf·CFA h
4.2

Manual J Peak cooling load Btu/sf·CFA h
6
**BUILDING INFORMATION**

- **Category:** Residential
- **Status:** In planning
- **Building type:** New construction
- **Year of construction:**
- **Units:** 224
- **Number of occupants:** 448 (Design)
- **Boundary conditions**
  - **Climate:** BOSTON LOGAN INT ARPT MA
  - **Internal heat gains:** 1.5 Btu/hr ft²
  - **Interior temperature:** 68 °F
  - **Overheat temperature:** 77 °F

**BELOW:**
- **ROOF:** R48
- **SLAB:** R15
- **WINDOWS:** R4 (INSTALLED)

**PASSIVEHOUSE REQUIREMENTS**

- **Certificate criteria:** PHIUS+ 2015 Standard

### Heating demand

- **specific:** 7.1 kBTU/ft² yr
- **target:** 5.3 kBTU/ft² yr
- **total:** 706524.07 kBTU/yr

### Cooling demand

- **specific:** 3.95 kBTU/ft² yr
- **target:** 2.9 kBTU/ft² yr
- **total:** 392712.11 kBTU/yr

### Heating load

- **specific:** 6.83 Btu/hr ft²
- **target:** 4.4 Btu/hr ft²
- **total:** 679533.72 Btu/hr

### Cooling load

- **specific:** 3.85 Btu/hr ft²
- **target:** 4.2 Btu/hr ft²
- **total:** 383236.55 Btu/hr

### Primary energy

- **specific:** 6132 kWh/Person yr
- **target:** 6200 kWh/Person yr
- **total:** 9373365.81 kBtu/yr

### Site energy

- **total:** 36.44 kBtu/ft² yr
- **building systems:** 43.36 kBtu/yr
- **photovoltaic savings:** 0 kBtu/ft² yr

### Air tightness

- **ACH50:** 2.00 1/hr
- **CFM50 per envelope area:** 4.00 cfm/ft²

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NAPHC 2016 - P+W CASE STUDIES - PARCEL 9
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PASSIVEHOUSE REQUIREMENTS
Certificate criteria: PHIUS+ 2015 Standard

Heating demand specific:
- target: 4.65 kBtu/ft² yr
- total: 463261.75 kBtu/yr

Cooling demand specific:
- target: 2.9 kBtu/ft² yr
- total: 273020.53 kBtu/yr

Heating load specific:
- target: 4.4 Btu/hr ft²
- total: 434872.12 Btu/hr

Cooling load specific:
- target: 4.2 Btu/hr ft²
- total: 370831.17 Btu/hr

Primary energy specific:
- target: 5956 kWh/Person yr
- total: 9103364.49 kWh/yr

Site energy total:
- building systems: 35.6 kBtu/ft² yr
- photovoltaic savings: 0 kBtu/ft² yr

Air tightness
ACH50:
- target: 0.4 1/hr

- ASSUMES PH AIRTIGHTNESS
- NIGHT FLUSHING @ .05 ACH50
(TO BRING DOWN COOLING DEMAND)

MODIFIED TO PH STANDARD (HOTEL ONLY)
WALLS: R25 (SAME)
ROOF: R48 (SAME)
SLAB: R15 (SAME)
WINDOWS: R4 (INSTALLED)

EVEN WITH CONVENTIONAL SYSTEMS LIKE CHILLERS/BOILERS
THIS IS OK (.08 CFM/FT² FOR NON-COMBUSTIBLE BUILDINGS OVER 5 STORIES)

NAPHC 2016 - P+W CASE STUDIES - PARCEL 9
## 1600 Wall Systems

<table>
<thead>
<tr>
<th>Glass U-Factor</th>
<th>Overall U-Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.48</td>
<td>0.61</td>
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<tr>
<td>0.46</td>
<td>0.60</td>
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<tr>
<td>0.44</td>
<td>0.58</td>
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<tr>
<td>0.42</td>
<td>0.56</td>
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<tr>
<td>0.32</td>
<td>0.48</td>
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<td>0.28</td>
<td>0.45</td>
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### 1” GLAZING WITH ALUMINUM PRESSURE PLATE

<table>
<thead>
<tr>
<th>Allowable Air</th>
<th>Water</th>
<th>NFRC U-Factor</th>
<th>CRF£</th>
<th>STC</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.06 cfm/sqft at 6.24 psf</td>
<td>15 psf</td>
<td>0.18 to 0.52 BTU/hr-sqft°F</td>
<td>78 to 83</td>
<td>31 to 49 (est.)</td>
</tr>
</tbody>
</table>

**NOTE:** For glass values that are not listed, linear interpolation is permitted.

1. U-Factors are determined in accordance with NFRC 100.
2. SHGC and VT values are determined in accordance with NFRC 200.
3. Glass properties are based on center of glass values and are obtained from your glass supplier.
4. Overall U-Factor, SHGC, and VT Metrics are based on the standard NFRC specimen size of 2000mm wide by 2000mm high (78-3/4” by 78-3/4”).

## CURRENT CURTAINWALL SYSTEMS

### HP-Wall™ Series

### TRIFAB® VG 451 (CENTER – Non-Thermal)

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### TRIFAB® VG 451T (CENTER – Thermal)

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### 1600UT System™1 Curtain Wall

**THERMAL PERFORMANCE MATRIX (NFRC SIZE)**
### 1600UT System™1 Curtain Wall

**THERMAL PERFORMANCE MATRIX (NFRC SIZE)**

<table>
<thead>
<tr>
<th>Thermal Transmittance $^1$ (BTU/hr • ft$^2$ • °F)</th>
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<tbody>
<tr>
<td>Glass U-Factor $^3$</td>
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<tr>
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</table>

**R-10**

#### TRIFAB® VG 451T (CENTER – Thermal)

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**R-3.6**

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**R-3.6**
CONCLUSIONS:

- AIRTIGHTNESS THROUGH DETAILING AND CONSTRUCTION IS CRITICAL TO ACHIEVING STANDARD

- BUILDING MASSING (SURFACE TO VOLUME RATIO) MUST BE CAREFULLY CONSIDERED

- PERCENTAGE AND R-VALUE OF GLAZING MUST BE CAREFULLY CONSIDERED

- SOME FLEXIBILITY ON MECHANICAL SYSTEMS POSSIBLE (WATCH OUT FOR PRIMARY ENERGY)

- FRAME PERFORMANCE OF CURTAIN WALLS COULD BE IMPROVED

- PASSIVE BUILDING STANDARD IS ACHIEVABLE FOR LARGE PROJECTORS, LET'S GO!
THANK YOU!

NAPHC 2016

PHILADELPHIA, PA / SEPTEMBER 23, 2016

ANDREW STEINGISER, RA, LEED AP, CPHC

PERKINS+WILL

PHIUS
Passive House Institute US