INTEGRATED DESIGN &
The Friends School of Portland

NESEA BuildingEnergy '16 Conference
02092016
Naomi C. O. Beal
passivhausMaine

Phil KaplaN
Kaplan Thompson Architects

PETER WARREN
WARREN CONSTRUCTION GROUP
- 8 years old
- NEASC accredited (2012)
- 90 students
- Pre-K through 8th grade
- excellent stewards of finances

new building requirements:

- completed by summer 2015
- 120 students
- a larger meeting room
- add 2 classrooms
- a new gymnasium (phase 2)
- room for a future addition
The Friends School of Portland challenges and empowers students to develop their intellectual, physical, emotional, creative and spiritual potential. We honor our students’ natural gifts as they learn to enter the world with confidence, competence, joy and a sense of purpose. We are guided by the Quaker values of simplicity, peace, integrity, community, equality, stewardship, and truth.
We value quiet discovery.

In essence, a school based in Nature
Looking across to the new Meeting Room
We value teamwork.
FSP future Energy costs
PROCESS
Building Committee - priorities
1. Learning environment
2. Healthy
3. Cost
4. Environmentally friendly
5. Low energy
6. Beautiful
Design Team PRIORIties
1. Learning environment
2. Low energy
3. Cost
4. Healthy
5. Beautiful
6. Environmentally friendly
no IEED certification

Net Zero was important

Passive house was only tangentially discussed
roof form had minor ramifications on energy modeling
<table>
<thead>
<tr>
<th>Energy Cost Optimization</th>
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### Energy Usage Data

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<tr>
<th>Building Type</th>
<th>Net Building Cost</th>
<th>Year</th>
<th>Building SQFT</th>
<th>Energy use (GJ)</th>
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### Maintenance Data

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### Other Information

- Additional remarks:
- Relevant codes:
- Other comments:
### Option A (previously C2):
**Superinsulated Net Zero**

- 0.6 ACH50
- R-32 Sublab (8" EPS)
- R-20 Foundation Walls
- R-46 Walls (2x6, cellulose, 4" foam)
- R-93 Roof 1 (26" Loose Cellulose)
- R-80 Roof 2 (14" TJI, DPC, 4" foam)
- Heat Pumps (Mini Splits)
- U-0.16 Windows and Doors (uPVC)

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<th>Component</th>
<th>Cost</th>
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<td><strong>Total</strong></td>
<td><strong>$2,648,100</strong></td>
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### Option B (previously F):
**Passive House**

- 0.5 ACH50
- R-50 Sublab (12.5" EPS)
- R-20 Foundation Walls
- R-53 Walls (Porter Panels)
- R-122 Roof 1 (34" Loose Cellulose)
- R-80 Roof 2 (14" TJI, DPC, 4" foam)
- Heat Pumps (Mini Splits)
- U-0.16 Windows and Doors (uPVC)

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<td><strong>Total</strong></td>
<td><strong>$2,648,100</strong></td>
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**TOTAL mortgage COST/MONTH**

- $17,888.14
- $18,419.72
INSULATION STRATEGIES

1- TJI ROOF W/ DPC + 4" POLYISO - R-88
2- TRUSS ROOF W/ 24" LBC - R-100
3- 2X6 WALL W/ DPC + 4" POLYISO - R-46
4- 6" CONC. SLAB W/ 12" EPS FOAM - R-57
CHALLENGES

HEAVILY SHADED SITE

VENTILATION DESIGN REQUIREMENTS

BUDGETARY CONSTRAINTS

WINTER CONSTRUCTION
# PATHFINDER RESULTS

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**AVERAGE SUN PATHS FOR EACH MONTH**

FOR 37°–43° N LAT
24’-11”!
INHAUS DASHBOARD
(IN EVERY HOUSE OR HAUS)
**PHPP First Cut: Typical Values**

**Peak Load:** 69,585 BTU/hour

**Primary Energy:** 31.93 KBTU/ft²/year

**Annual Heating:** 8.84 KBTU/ft²/year

**Annual Cooling:** 0.66 KBTU/ft²/year

**Ventilation:** 70% efficient

**Air Tightness:** 0.60 ACH50

**R-Values**
- Slab: 20.0
- Walls: 40.0
- Roof: 60.0
- Truss Roof: 60.0
- TJI Roof: 60.0

**Windows & Doors**
- SHGC: 0.50
- U-Value Glass: 0.15
- U-Value Frame: 0.30
- U-Value Unit: 0.22

**Glazing % of TFA**

**Heat Gains**
- Solar Gains: 26%
- Internal Gains: 32%
- Mechanical Heating: 41%

**Heat Loss**
- Building Shell: 53%
- Ventilation & Air Leaks: 21%
- Windows: 26%

**Window Energy:** (19,491) KBTU/year

**SHELL Losses**
- Walls: 38%
- Roof: 25%
- Floor Slab: 37%

**June 2013**
### PHPP: ZEHNDER & HIGH SHGC

**Peak Load**: 64,700 BTU / Hour  
**Primary Energy**: 30.69 BTU / SF / Year  
**Annual Heating**: 7.46 KBTU / SF / Year  
**Annual Cooling**: 0.78 KBTU / SF / Year

<table>
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<tr>
<th>VENTILATION</th>
<th>88% Efficient</th>
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<td>Air Tightness</td>
<td>0.60 ACH50</td>
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</table>

**R-Values**
- Slab: 20.0
- Walls: 40.0
- Roof: 60.0
- Truss Roof: 60.0
- TJI Roof: 60.0

**Windows & Doors**
- SHGC: 0.55
- U-Value Glass: 0.15
- U-Value Frame: 0.30
- U-Value Unit: 0.22

**Glazing % of TFA**
- 5.0%
- 2.9%
- 1.6%
- 1.2%

**Heat Gains**
- Solar Gains: 29%
- Internal Gains: 34%
- Mechanical Heating: 37%

**Heat Loss**
- Building Shell: 56%
- Ventilation & Air Leaks: 16%

**Shell Losses**
- Walls: 38%
- Roof: 25%
- Floor Slab: 36%

**Window Energy**: (15,696) KBTU / Year

**JULY 2013**
PHPP: MORE INSULATION

PEAK LOAD: 55,305 BTU/HOUR
PRIMARY ENERGY: 29.55 kBtu/SF/YEAR
ANNUAL HEATING: 5.07 kBtu/SF/YEAR
ANNUAL COOLING: 1.26 kBtu/SF/YEAR

VENTILATION: 63% EFFICIENT
AIR TIGHTNESS: 0.60 ACH50

R-VALUES:
- SLAB: 57.4
- WALLS: 46.2
- ROOF: 95.2
- TRUSS ROOF: 100.2
- TJI ROOF: 87.8

WINDOWS & DOORS:
- SHGC: 0.62
- U-VALUE GLASS: 0.11
- U-VALUE FRAME: 0.17
- U-VALUE UNIT: 0.16

GLAZING % OF TFA:
- 5.0%
- 2.9%
- 1.8%
- 1.2%

WINDOW ENERGY: 6,108 kBtu/YEAR

HEAT GAINS:
- SOLAR GAINS: 32%
- INTERNAL GAINS: 37%
- MECHANICAL HEATING: 30%

HEAT LOSS:
- BUILDING SHELL: 43%
- VENTILATION & AIR LEAKS: 34%
- WINDOWS: 23%

SHELL LOSSES:
- WALLS: 51%
- ROOF: 24%
- FLOOR SLAB: 24%
PHPP: RENEEWAIRE & INTUS

PEAK LOAD: 51,848 BTU / HOUR
PRIMARY ENERGY: 28.86 kBTU / SF / YEAR
ANNUAL HEATING: 4.24 kBTU / SF / YEAR
ANNUAL COOLING: 1.26 kBTU / SF / YEAR

VENTILATION: 75% EFFICIENT
AIR TIGHTNESS: 0.60 ACH50

R-VALUES:
- SLAB: 57.4
- WALLS: 46.2
- ROOF: 95.2
- TRUSS ROOF: 100.2
- TJI ROOF: 87.8

WINDOWS & DOORS:
- SHGC: 0.62
- U-VALUE GLASS: 0.11
- U-VALUE FRAME: 0.17
- U-VALUE UNIT: 0.16

GLAZING % OF TFA:
- GLAZING: 5.0%
- 2.9%
- 1.8%
- 1.2%

WINDOW ENERGY: 6,108 KBTU / YEAR

HEAT GAINS:
- SOLAR GAINS: 34%
- INTERNAL GAINS: 38%
- MECHANICAL HEATING: 28%

HEAT LOSS:
- BUILDING SHELL: 46%
- VENTILATION & AIR LEAKS: 29%
- WINDOWS: 25%

SHELL LOSSES:
- WALLS: 52%
- ROOF: 24%
- FLOOR SLAB: 23%
- ROOF: 24%
**CURRENT PHPP: .5 ACH 50**

### Peak Load
- **Primary Energy**: 28.64 kBtu / sf / year
- **Peak Load**: 48,525 BTU / hour

### Annual Heats
- **Annual Heating**: 3.97 kBtu / sf / year
- **Annual Cooling**: 1.26 kBtu / sf / year

### Ventilation
- **% Efficient**: 75%
- **ACH50**: 0.50

### R-Values
- **Slab**: 57.4
- **Walls**: 46.2
- **Roof**: 95.2
- **Truss Roof**: 100.2
- **TJI Roof**: 87.8

### Windows & Doors
- **SHGC**: 0.62
- **U-Value Glass**: 0.11
- **U-Value Frame**: 0.17
- **U-Value Unit**: 0.16

### Glazing % of TFA
- **Glazing**:
  - 5.0%
  - 2.9%
  - 1.8%
  - 1.2%

### Heat Gains
- **Solar Gains**: 34%
- **Mechanical Heating**: 27%
- **Internal Gains**: 39%

### Heat Losses
- **Building Shell**: 47%
- **Ventilation & Air Leaks**: 27%
- **Windows**: 26%

### Window Energy
- **6,108** kBtu / year

### Shell Losses
- **Walls**: 52%
- **Roof**: 24%
- **Floor Slab**: 23%
AS MODELED (PHPP): 0.50 ACH 50
ACTUAL (FINAL TEST): 0.32 ACH 50

PEAK LOAD: 48,525 BTU/HOUR
PRIMARY ENERGY: 28.64 KBTU/SF/YEAR

ANNUAL HEATING: 3.97 KBTU/SF/YEAR
ANNUAL COOLING: 1.26 KBTU/SF/YEAR

VENTILATION: 75% EFFICIENT
AIR TIGHTNESS: 0.50 ACH 50

R-VALUES:
- SLAB: 57.4
- WALLS: 46.2
- ROOF: 95.2
- TRUSS ROOF: 100.2
- TJI ROOF: 87.8

WINDOWS & DOORS:
- SHGC: 0.62
- U-VALUE GLASS: 0.11
- U-VALUE FRAME: 0.17
- U-VALUE UNIT: 0.16

GLAZING % OF TFA:
- South: 5.0%
- North: 2.9%
- East: 1.8%
- West: 1.2%

WINDOW ENERGY: 6,108 KBTU/YEAR

HEAT GAINS:
- SOLAR GAINS: 34%
- MECHANICAL HEATING: 27%
- INTERNAL GAINS: 39%

HEAT LOSS:
- BUILDING SHELL: 47%
- VENTILATION & AIR LEAKS: 27%
- WINDOW WSS: 26%

SHELL LOSSES:
- WALLS: 52%
- ROOF: 24%
- FLOOR SLAB: 23%

21
size (in SF)  15,500
Building     $3.04 M

BUILDING Cost/sf = $196
Commodity marketplace pricing

WELL PLANNED = less expensive
Commodity marketplace pricing

Purposefully “American” details

R-88 to 100 roof typ.

R-46 walls typ.

R-57 subslab typ.
THRESHOLD DETAILS
2" x 2" FIBERGLASS SUB-SILL WITH FOAM FILLER
NO DRILLING AIRTIGHT CONSTRUCTION

NO CUTTING AIRTIGHT MEMBRANES

REPORT ALL PENETRATIONS TO SUPERVISOR
CONCLUSION

CLEAR VISION, SHARED VALUES

EARLY, INTEGRATED DESIGN TEAM

LEADERSHIP