The House: Theory vs. Practice

BEFORE PANEL SUPPORTS SEALED

AFTER PANEL SUPPORTS SEALED
Eliminate Thermal Bridging
### Eliminate Thermal Bridging

Total: 18,904

= 6% of the total heat loss through the facade.

### Thermal bridge inputs

<table>
<thead>
<tr>
<th>Nr.</th>
<th>Thermal bridge description</th>
<th>Group Nr.</th>
<th>Assigned to group</th>
<th>Qty</th>
<th>User determined length [ft]</th>
<th>(\ell) [ft]</th>
<th>Input of thermal bridge heat loss coefficient BTU/hr.ft.F</th>
<th>(\Psi) BTU/hr.ft.F</th>
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<tr>
<td>6</td>
<td>Wall Panel Bridges</td>
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<td>7</td>
<td>Panel to panel (W)</td>
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<td>Panel corner</td>
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<td>Vertical Joint (V)</td>
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Total: 18,904
Sendero Verde: Heating & Cooling

- **Floor Mounted Air Handling Unit** (1- 2- & 3-bedroom units)
- **Wall Mounted Air Handling Unit Unit** (Studio units)

**Condenser**
Vertical Reveal Grille

Condenser
Exhaust Duct

Condenser
Lessons Learned

• Thermal Insulation: U-factor of 0.36 (ASTM C1363/NFRC 102-2014) for maximum energy efficiency. The U-Factor of 0.36 and Air Infiltration (NFRC 400-2014/ASTM E283) of \( \leq 0.1 \text{ cfm/f } 2 \) was achieved in an operable condition using the Ceco Mercury Thermal Break Frame and Pemko Thermal Barrier Saddle. The building's actual energy performance and potential savings is a combination of the openings thermal efficiency and ability to reduce air infiltration/exfiltration.

• Physical endurance testing: Meets ANSI A250.4 performance test, level A (4,000,000 cycles) class 1 stiffness

• Hurricane rating: Up to and including +/- 100 psf 3'0" x 7'0" single or +/- 70 psf 8'0" x 8'0" pairs with weather kerf frame and cylindrical lock, mortise lock or rim exit device. U-Factor 0.38, R-Value 2.6 (NFRC 102-2014)

• Fire rating: Up to and including 3 hours 4'0"x 8'0" singles and 8'0"x 8'0" pairs (UL10C) UL & (4'0" x 8'0" singles WH 1-1/2hr max)

Approximately 40% of all energy leakage comes from the building envelope* this includes exterior doorways. Trio-E doors installed with Ceco Door Thermal Break frames and Pemko Thermal Barrier Saddles help increase thermal retention and reduce energy leakage.

*Tony Woods, Air tight buildings, 2005
BALANCED VENTILATION WITH HEAT RECOVERY
CENTRAL SYSTEMS

Ventilation

THE HOUSE

SENDERO VERDE BLDG A

CENTRAL: MAIN RISER

CENTRAL: RISER PER UNIT

Fresh Air
Exhaust Air
Ventilation: Horizontal Distribution

**THE HOUSE**

**SENDERO VERDE BLDG A**
Ventilation: Individual Risers vs. Common Riser Return

THE HOUSE

SENDERO VERDE BLDG A
Domestic Hot Water

- Hot water used for drinking, food prep, sanitation, and personal hygiene
- NOT for heating, swimming pools, commercial cooking, etc.
Passive House High Rise: NYC

- Domestic Hot Water: 34%
- Plug Loads: 29%
- Lighting: 13%
- Pump & Aux Elec: 13%
- Heating Energy: 5%
- Cooling Energy: 6%
- DHW Demand: 13%
Most Common Mid & Highrise: Central Gas w/Recirculation
Individual Riser Recirculation

1. Dedicated recirculation pipe per riser
2. Automatic venting through fixtures
3. Single floor for distribution and return
4. Less distribution floors required per zone
5. Quickest hot water delivery
6. High energy loss due to extensive piping
Central Recirculation

1. Common recirculation pipe
2. Individual vents per riser that require access
3. Separate distribution and collection loop located on different floors
4. Additional floor height is typically required
5. Reduction in total installed pipe and heat loss - much more energy efficient
6. Slower hot water delivery response time
Final Blower Door Test

- Final Blower Door Test results for The House were .15 Air Change/Hour (ACH).
- Passive House requirements allow a maximum .6 ACH.
425 Grand Concourse
Mixed Use

- Residential
- Medical facility
- Educational facility
- Cultural facility
- Retail
- Parks comfort station
425 Grand Concourse
Ground Floor Plan
425 Grand Concourse
Residential Floor Plan
425 Grand Concourse
Energy Efficiency - Envelope

<table>
<thead>
<tr>
<th>Envelope Efficiency Requirements</th>
<th></th>
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<tbody>
<tr>
<td>Roof</td>
<td>R-30</td>
</tr>
<tr>
<td>Above Grade Walls</td>
<td>R-20 effective</td>
</tr>
<tr>
<td>Below Grade Walls</td>
<td>R-10</td>
</tr>
<tr>
<td>Windows – Effective U-value</td>
<td>0.25 Btu/hr.ft².F</td>
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<tr>
<td>Glazing SHGC</td>
<td>0.27</td>
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<tr>
<td>Façade Air Tightness</td>
<td>0.08 cfm/sf-façade @ 50 Pascals</td>
</tr>
</tbody>
</table>
425 Grand Concourse
Energy Efficiency – Heating & Cooling

• In order to not oversize equipment
  – Utilized single “ductless” console unit to serve two rooms, where possible
  – Worked with manufacturer to allow condensing units to be overconnected
  – Worked with manufacturer to limit the capacity of the evaporator units, as needed
425 Grand Concourse
Energy Efficiency – Appliances, Plugs

- Appliances
  - All Energy Star appliances
    - Except for commercial dryers
  - No ice makers in refrigerators
- Dwelling unit plug loads are a big wild card in MF buildings
  - Energy monitoring w/ tenant dashboard proposed

![Energy Star Refrigerators](chart.png)
Moisture Control & Affordable Housing

- Greater occupant density
- Interior moisture generation rates ↑
- All exhaust air through an H/ERV
- PH natural infiltration very low (0.03 cfm/sf. @ 10 mph wind)
  - 5 to 10 times less than typical buildings
  - Moisture must get out through ventilation air
- ERV vs HRV...
Why Care About Internal Moisture?
Dew Point Temperature

- 53°F
- 49°F
- 43°F
Individual ERV Design

- Sensible recovery efficiency = 80%
- **Moisture recovery efficiency**
  - Summer = 61%
  - **Winter = 77%**
- Code minimum vent rates
  - 0.48 ACH for dwelling units on average
  - Option to boost (1.11 ACH)
Moisture Modeling - Results

• **Goal**: how high will interior RH get?
  – **Answer**
    • Weekdays – peak conditions between 50-63%
    • Weekends – most of the day between 50-70%

• **Goal**: is ERV boost enough?
  – **Answer**
    • Does help, but not enough
    • Supplemental dehumidification required
Central ERV Design

ERVs on high roof to supply upper floors

Constant Air Regulators (CARs) on each floor maintain a balanced system

ERVs on low roof to supply bottom floors
Revised Modeling Parameters

- Output – RH of interior air in apartments @ 68°F
- Same moisture generation assumptions
- Central ventilation → air mixing of moisture generation
- Moisture recovery efficiency
  - Summer Time = 72%
  - Winter Time = 83%
- Continuous code minimum exhaust
  - 0.60 ACH for dwelling units on average
Partial ERV Core Bypass

6AM-8AM
Daily Model - Winter Weekend - Mixed Air Model

- Partial ERV Core Bypass
  - 7AM-9AM
  - 6PM-7PM

Graph showing interior RH and hourly moisture generation with different legend entries.
What We Learned & Key Factors

1. Occupant density is extremely important
   – As low as 200 sf/person in 2 & 3-BR units

2. Winter-time ERV moisture transfer
   – About 70-80%
   – Summer-time efficiencies can be much lower

3. Façade exfiltration rates
   – Very low for super-airtight construction

4. Condensation risk @ thermal weak-points in façade
   – Usually window to wall connections

5. Potentially significant utility costs for supplemental dehum.
   – $2-$15 per unit per month
Questions?
Thank you!

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