



# Designing and Constructing a High-Performance Building Envelope for Multi-Unit Affordable Housing

Jeffrey Davis, AIA, LEED AP  
FortyEighty Architecture

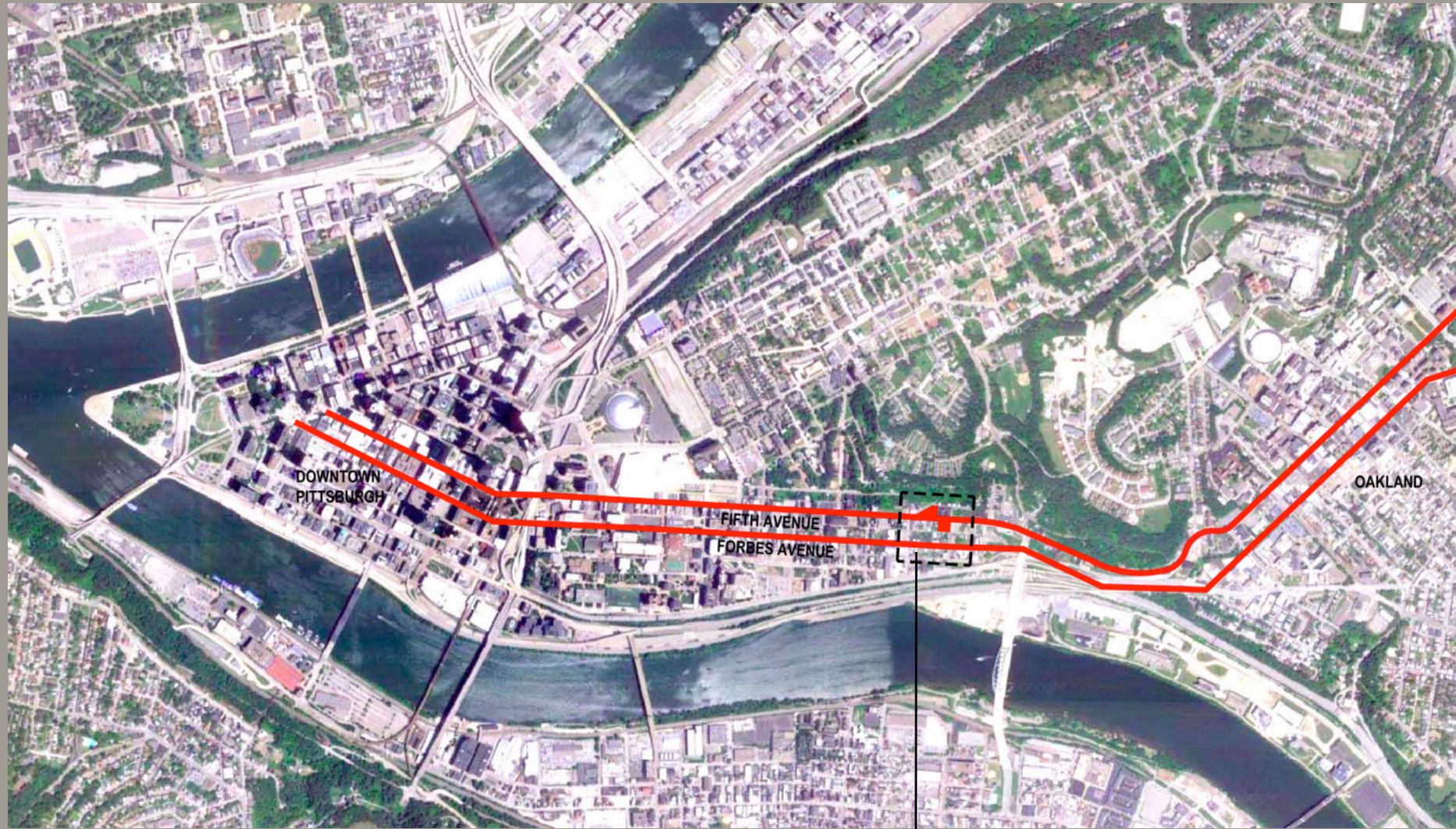
Debbie Clark, NCARB, LEED AP  
FortyEighty Architecture

Rob Hosken, RA, CEM  
Building Performance Architecture



### Project Sites

Designing and Constructing a High-Performance Building Envelope for Multi-Unit Affordable Housing



Neighborhood Context

PROJECT SITE

Designing and Constructing a High-Performance Building Envelope for Multi-Unit Affordable Housing



Neighborhood Context

Designing and Constructing a High-Performance Building Envelope for Multi-Unit Affordable Housing



## Neighborhood Context

Designing and Constructing a High-Performance Building Envelope for Multi-Unit Affordable Housing

# Uptown Lofts on Fifth, Pittsburgh, Pennsylvania

## Project Team:

*Client:* ACTION-Housing, Inc.; Pittsburgh, Pennsylvania

*Tax Credit Financing:* Pennsylvania Housing Finance Authority; Harrisburg, Pennsylvania

*Architect:* FortyEighty Architecture; Pittsburgh, Pennsylvania.

*Certified Passive House Consultant:* Kaplan Thompson Architects; Portland, Maine

*Mechanical, Electrical & Plumbing Engineer:* Iams Consulting; Pittsburgh, Pennsylvania

*Structural Engineer:* Keystone Structural Solutions; Pittsburgh, Pennsylvania

*Civil Engineer & Landscape Architect:* Langan Engineering & Environmental Services

*Sustainable Design Consultant:* Center for Building Performance and Diagnostics at Carnegie Mellon University; Pittsburgh, Pennsylvania.

*PHIUS+ and HERS Rater:* Building Performance Architecture; Pittsburgh, Pennsylvania

*Constructor:* Mosites Construction; Pittsburgh, Pennsylvania

## PHFA *Innovation in Design* Award:

The project's tax credit application was selected for an *Innovation in Design* award from the Pennsylvania Housing Finance Agency in special recognition of its:

- Excellence in Design
- Implementation of current and future energy efficient technologies
- Leveraging community and capital resources

# Design Criteria:

## **Applicable Building Codes:**

- Pennsylvania - 2009 ICC Building Codes
- 2012 IECC (R-values - Owner requested, DOE Challenge Home requirement)

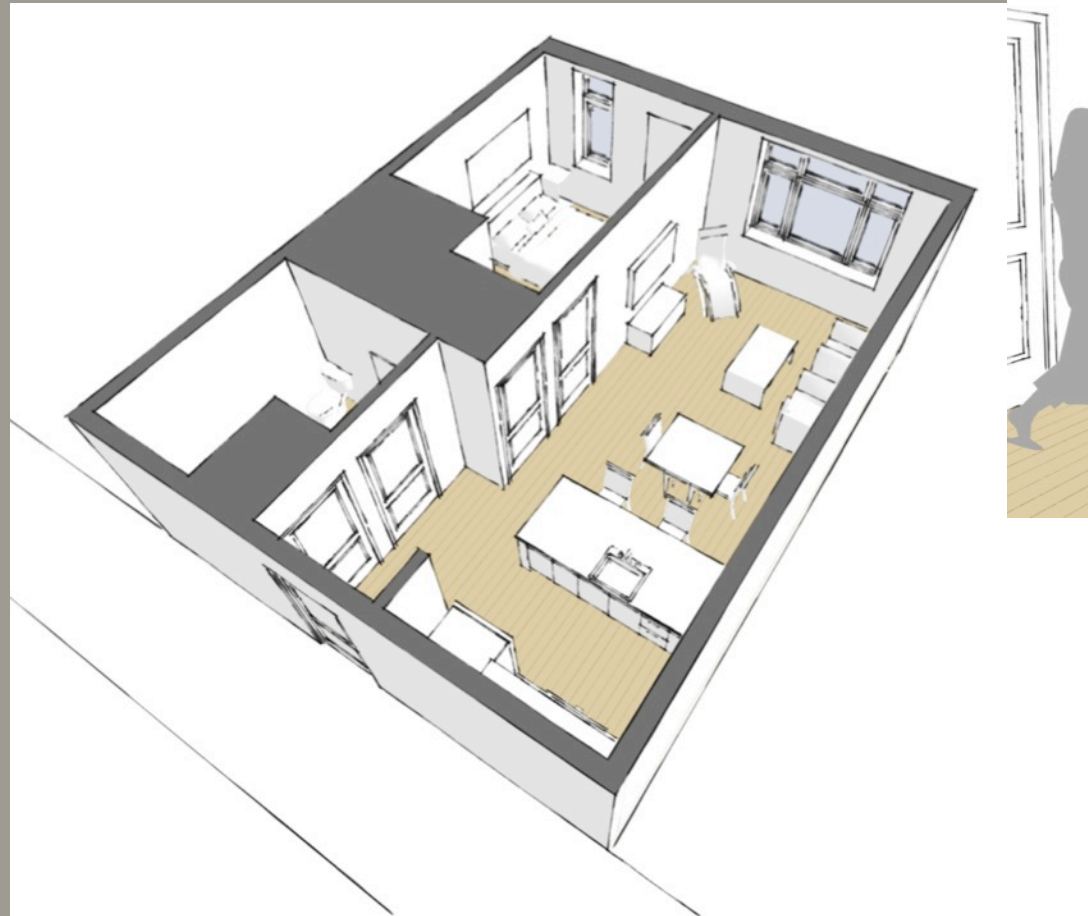
## **PHFA Energy Conservation/Green Building Criteria:**

- U-values of building enclosure must exceed 2009 IECC by 10%
- Meet Energy Star<sup>®</sup> Certified Homes (version 3.0)

## **Additional North Building Criteria:**

- Passive House Certification (PHIUS+) and the companions programs:
- EPA Indoor AirPLUS
- DOE Challenge Home program





Typical One-Bedroom Apartment Unit



North Building - Residential Floor



North Building - Ground Floor



South Elevation

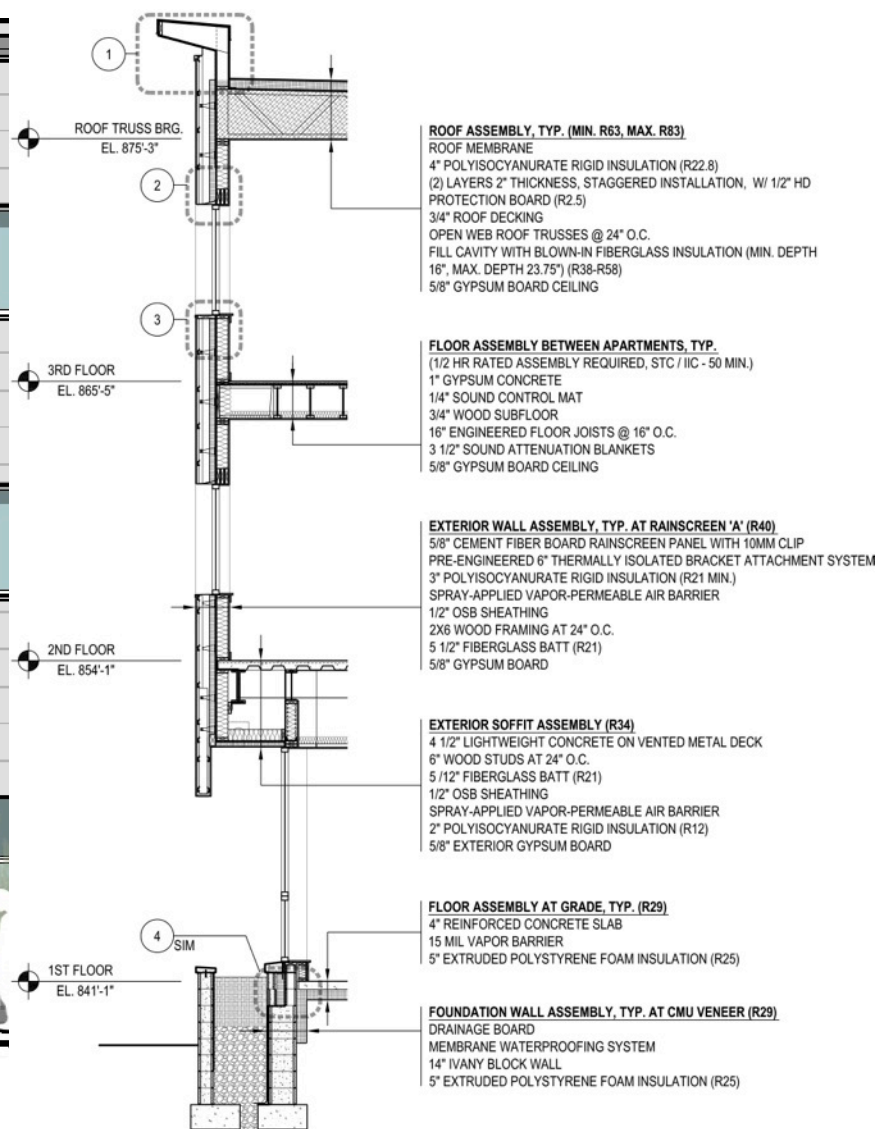
Designing and Constructing Multi-Unit Housing as a Comparison for Envelope Performance and Energy Savings



West Elevation



North Elevation



## Fiber Cement Rainscreen



TECHNICAL DATA SHEET  
**Air-Bloc® 33MR**  
 Fluid Applied, Vapor Permeable,  
 Air & Weather Barrier Membrane


**Typical Physical Properties**

<b>-Color</b>	Black	<b>-Watertightness</b> CAN/CGSB-37.58-M86	Pass
<b>-Solids by Weight</b>	65%	<b>-Water Vapor Permeance</b> ASTM E96 @ 1/8" (3 mm) wet film	11.6 perms (655 ng/Pa.m <sup>2</sup> .s)
<b>-Weight/unit volume</b>	12 lbs/gal (1.4 kg/l)	<b>-Air Permeability Tests</b> ASTM E283, Applied to CMU	
<b>-Drying Time @ 50% R.H.</b> +20°C (68°F) on Dry Substrate	2 Hours to touch dry 24 Hours to firm dry	75 Pa @ 70°F	0.0016 cfm/ft <sup>2</sup>
<b>-Service Temperature</b>	-40°F to +185°F (-40°C to +85°C)	250 Pa @ 70°F	0.0034 cfm/ft <sup>2</sup>
<b>-Application Temperature</b>	40°F to 122°F (+4°C to +50°C)	500 Pa @ 70°F	0.0050 cfm/ft <sup>2</sup>
<b>-Tensile Strength,</b> ASTM D412	125 psi (860 kPa)	ASTM E2357, Assembly Air Leakage Testing	Pass
<b>-Elongation, typical</b> ASTM D412	200%	ASTM E2178 @ 75Pa	0.0016 cfm/ft <sup>2</sup> (0.008 L/s.m <sup>2</sup> )
<b>-Aging - Long Term Flexibility</b> CGSB 71-GP-24M	No fracturing	<b>-Resistance to Gust Wind Load</b>	Meets Mass/Canadian code requirements for air leakage @ 3000Pa gust load suction pressure
<b>-Nail Sealability</b> ASTM D 1970	Pass	<b>-Chemical Resistance</b>	Resists mild acids and alkalis, oil, grease, petroleum solvents and salt solutions
<b>-Resistance To Mold, Mildew &amp; Fungal Growth</b> ASTM D5590 -00	-0- No Growth	<b>-Fire Testing</b>	Complies with NFPA 285 in various wall assemblies
<b>-Weather Resistance</b> Q-UV Exposure - 73 daily cycles of UV and water spray with no observable deterioration	Pass	<b>-Flame Spread</b> ASTM E84	25
<b>-VOC content</b>	100 grams per liter, max.	<b>-Smoke Developed</b> ASTM E84	85



Air Barrier

Designing and Constructing a High-Performance Building Envelope for Multi-Unit Affordable Housing



## MFI-SYSTEM: EASILY MEET & EXCEED ENERGY CODE REQUIREMENTS WITH LESS EXTERIOR MINERAL FIBER INSULATION & MAXIMUM VERSATILITY.

INSTALL RAILS HORIZONTALLY OR VERTICALLY

KNIGHT WALL SYSTEMS' THERMALLY ISOLATED BRACKET ATTACHMENT SYSTEM DRAMATICALLY DECREASES THE THERMAL BRIDGING FOUND WITHIN RAIN SCREEN SYSTEMS, WHILE PROVIDING LIMITLESS DESIGN OPTIONS FOR BUILDING FACADES; COMBINING ENERGY EFFICIENCY, FACADE VERSATILITY, MOISTURE CONTROL AND SUSTAINABILITY.

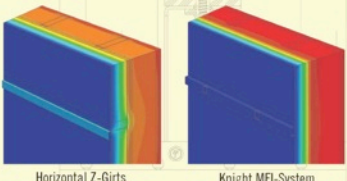
**ADVANTAGES TO KNIGHT WALL SYSTEMS' MFI-SYSTEM™:**

- Easily attain code compliance with exterior mineral fiber insulation
- Brackets can be spaced up to 30" O.C. vertically or every other stud (32" O.C.)
- High corrosion-resistant Zn-Al-Mg ZMA0 coating for a long service life vs typical Galvanized steel
- Exterior insulation fits tight around brackets without trimming unlike other bracket systems
- Attach nearly any cladding - supplied by any manufacturer
- All components are pre-engineered and third party tested for proven performance and durability
- Excellent ventilation with a constant 1/4-inch, or optional 1 1/2-inch, continuous rain screen cavity
- Easily straighten façades with an integrated adjustment feature or specific purpose built shims

**ASHRAE 90.1 PRESCRIPTIVE REQUIREMENT\*:**  $R_{eff} = -15.6$  (U-0.064)  
**MFI-SYSTEM™ + 3.5" of mineral fiber\*:**  $R_{eff} = -15.7$  (U-0.0637)

**EXTERIOR INSULATION EFFECTIVENESS AS COMPARED TO ITS RATED R-VALUE WITH\*...**

...Vertical Z-Girts:	~40%
...Horizontal Z-Girts:	~52%
...Aluminum Brackets:	~62%
...the MFI-SYSTEM:	~82%



Horizontal Z-Girts      Knight MFI-System

\*ASHRAE 90.1 prescriptive requirement for steel frame walls; all R-values units are ft<sup>2</sup> • h • ft<sup>2</sup> / Btu  
 \*Base wall assembly: brackets or girts spaced at 24" O.C., mineral fiber insulation R-4.2/in, AW barrier, exterior gypsum board, empty steel stud cavity (16" O.C.), interior gypsum board

For material performances, submittal sheets, CAD drawings and MSDS sheets see [WWW.H-B.COM](http://WWW.H-B.COM)

## MASONRY SYSTEMS

### 2-SEAL TIE™ VENEER ANCHORS

#### THERMAL 2-SEAL™ WING NUT

An innovative single screw veneer tie for metal stud construction. The Thermal 2-Seal™ Wing Nut Tie features a dual-diameter barrel with factory-installed EPDM washers to seal both the face of the insulation and the air/vapor barrier.

**NEW FEATURE!**

- UL-94 plastic encapsulating a polymer-coated wing to create a thermal break, decreasing thermal transfer through rigid insulation.
- Polymer-coated wing maintains integrity of the anchor system in case of fire making it superior to other thermal anchors on the market.
- Larger diameter washer holds insulation in place during installation.
- Wings accept a standard, seismic or Mighty-Lok® Pintle and spin to easily orient pintles/hooks with masonry joints.
- Allows up to a 1/2" of adjustability to account for variations in wall thickness and completely seal the insulation from water and air intrusion.

Barrel portion is polymer-coated with a 5/16" hex head and integrated screw. Available in lengths of 5/8", 1", 1-1/2", 2", 2-1/2", 3", 3-1/2", 4" and 4-1/2" to accommodate insulation.

**For wood or concrete applications, use Concrete Thermal 2-Seal™ Tie. For steel stud with wood sheathing, use Standard Thermal 2-Seal™ Tie.**

**U.S. Patent: 7,415,803 & 8,613,175**  
Other Patents Pending



**H&B's Stainless Steel barrels have one-quarter the thermal conductivity of carbon steel barrels and one-seventh the thermal conductivity of our competitors' zinc barrels.**

Metal Type	Thermal Conductivity (W/m K)
AISI-SAE 1020 (Plain Carbon Steel)	0.52
Stainless Steel (Type 304)	0.15
Zinc (Commercial)	1.1

Please visit [www.h-b.com](http://www.h-b.com) for more information on Hohmann & Bamard material specifications.

The 2-Seal Tie™ Anchors meet or exceed requirements of the **Commonwealth of Massachusetts State Building Code** for air leakage and water penetration. Contact H&B's technical department for test results.

#### 2-SEAL™ TIE

An innovative single-screw veneer tie for metal stud construction. Fabricated from Zamak zinc with a premium quality organic polymer coating, the 2-Seal™ Tie has a dual-diameter barrel with factory-installed EPDM washers to seal both the face of the insulation and the air/vapor barrier. This is an improvement over single barrel types which only seal at the insulation and render the vapor barrier susceptible to air and moisture infiltration if not precisely installed (perfectly perpendicular to the stud).

The dual-barrel has an integrated #12 self-drilling screw, and is available for insulation from 5/8" - 4" thick. The projecting eyelet accepts the 2-Seal™ **Byna-Lok Wire Tie** for the masonry veneer wall mortar joint.

Barrel portion available in 5/8", 1", 1-1/2", 2", 2-1/2", 3", 3-1/2", 4" and 4-1/2" lengths to accommodate insulation. Available polymer-coated which allows stainless steel wire ties to be used preventing galvanic reaction from dissimilar metals.

**For wood or concrete applications please use Concrete 2-Seal™ Tie. For steel stud with wood sheathing, use Standard 2-Seal™ Tie.**

**U.S. Patent: 8,037,653**  
**CAN. Patent: 2,690,819**

Installation chuck adapter sold separately.

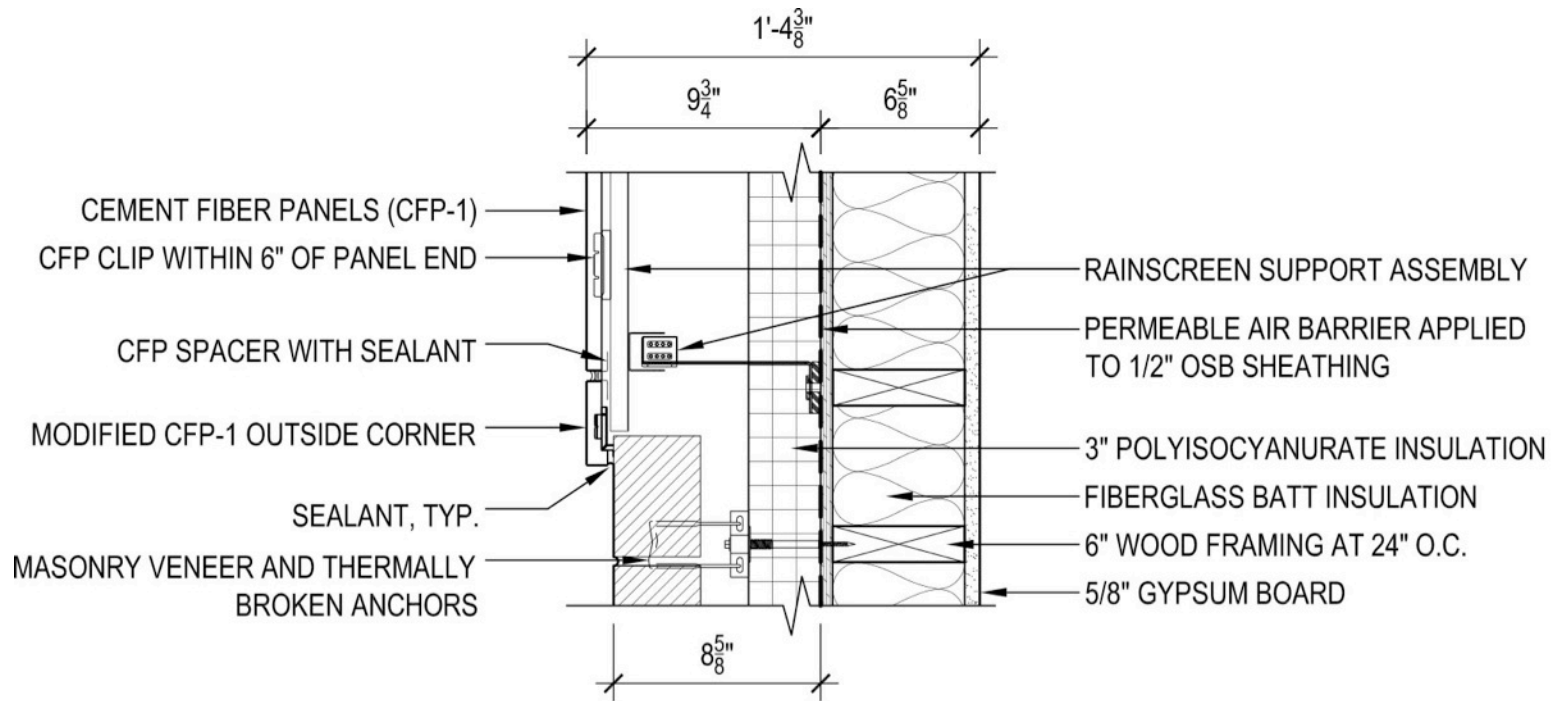


**Stainless Steel transfers 75% less thermal energy than Carbon Steel**

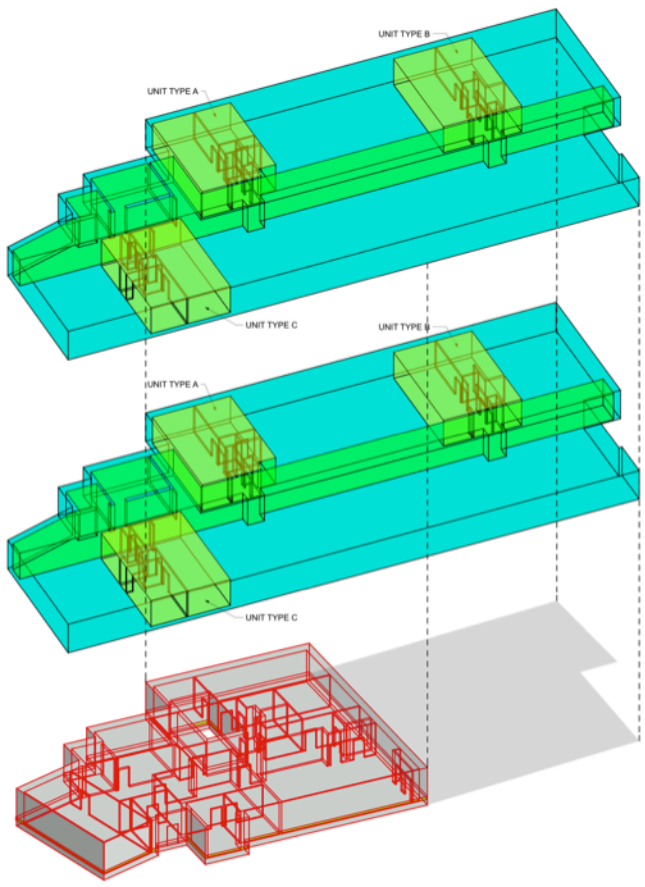
## Thermally Broken Rainscreen Cladding Support

Designing and Constructing a High-Performance Building Envelope for Multi-Unit Affordable Housing





## Fiber Cement & Masonry Rainscreen – Typical Exterior Wall



4 VOLUME DIAGRAM  
SCALE: 1/8"=1'-0"



3 THIRD FLOOR TFA



2 SECOND FLOOR TFA

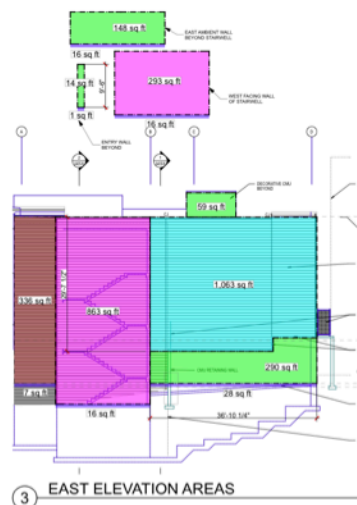


1 GROUND FLOOR TFA

# PHPP Model – TFA Calculations

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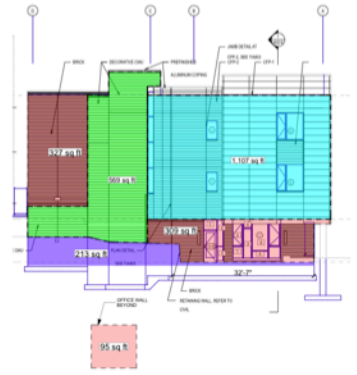
- ASSEM. 6  
CMU TYPE 2 / BRICK
- ASSEM. 7  
FIBER CEM.
- ASSEM. 8  
CMU ELEV./STAIR
- ASSEM. 1  
CMU TYPE 1
- ASSEM.5  
BASEMENT WALL
- ASSEM.12  
BASEMENT WALL 2



3 EAST ELEVATION AREAS



1 SOUTH ELEVATION AREAS



4 WEST ELEVATION AREAS



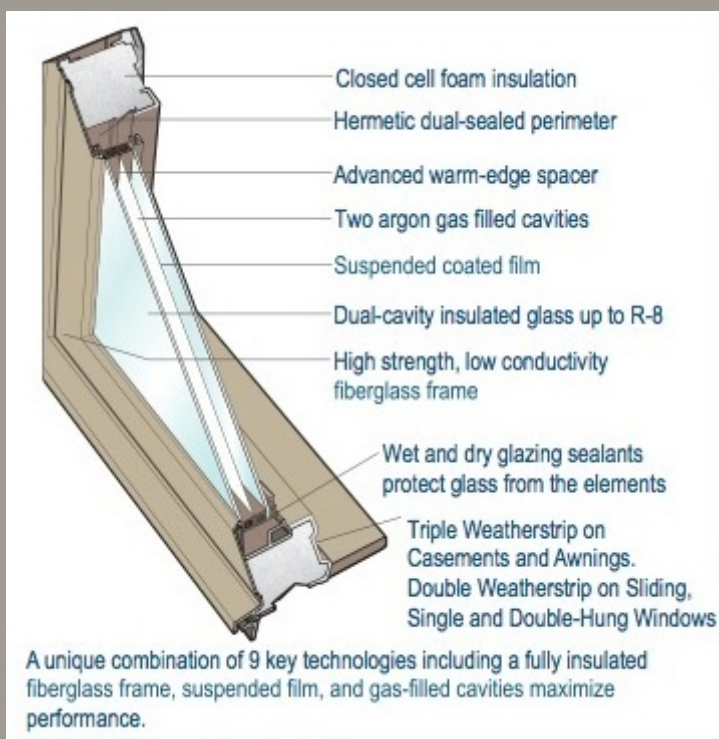
2 NORTH ELEVATION AREAS

# PHPP Model – Wall Assembly Types/Area Calculations

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# Alpen 525 Series

- Fiberglass frames with 1-3/8" triple-pane glazing. High-SHGC low-E coated clear glass with interior suspended film, and argon gas.
- PHIUS Certified (Feb. 2015)



## ALPEN WINDOW SUBMITTAL DOCUMENTS UPTOWN LOFTS – NORTH BUILDING

### b. THERMAL:

#### i. NFRC Full-Frame:

Windows are rated per NFRC 100-2010 and NFRC 200 with following full-frame performances, including 1-3/8" overall thickness glass with two 1/8" glass panes in configuration specified above:

525-S Series	Glass Package		NFRC Full-Frame Performance				
	Type	Description	U-value	R-Value	SHGC	VT	CRF
Fixed Low Profile	Alpenglass 5SH	High Solar Gain: Single Film/Dual-Cavity, Argon Fill	0.17	5.9	0.48	0.62	68
Fixed High Profile	Alpenglass 5SH	High Solar Gain: Single Film/Dual-Cavity, Argon Fill	0.16	6.3	0.43	0.56	68
Casement Window	Alpenglass 5SH	High Solar Gain: Single Film/Dual-Cavity, Argon Fill	0.20	5.0	0.38	0.48	69

#### ii. Center of Glass (NFRC):

525-S Series	Glass Package		Center-of-Glass			
	Type	Description	U-value	R-Value	SHGC	VT
Fixed Low Profile	Alpenglass 5SH	High Solar Gain: Single Film/Dual-Cavity, Argon Fill	0.14	7.1	0.53	0.70
Fixed High Profile	Alpenglass 5SH	High Solar Gain: Single Film/Dual-Cavity, Argon Fill	0.14	7.1	0.53	0.70
Casement Window	Alpenglass 5SH	High Solar Gain: Single Film/Dual-Cavity, Argon Fill	0.14	7.1	0.53	0.70

#### iii. Passive House Performance Data (estimated):

Window Type	Frame Height (same all sides)		PHPP Data			
			Unit	PHPP U <sub>f</sub> * (U-Value Frame)	PHPP Ψ <sub>spacer</sub> **	U-cog***
525-S Fixed High Profile, 5SH	mm	72	W/m2-K	0.86	0.047	0.740
	in	2.83	(BTU/hr*Ft2°F)	0.15	0.026	0.13
525-S Fixed Low Profile, 5SH	mm	72	W/m2-K	1.22	0.047	0.740
	in	2.84	(BTU/hr*Ft2°F)	0.22	0.026	0.13
525-S Casement, 5SH	mm	73	W/m2-K	1.17	0.047	0.740
	in	2.86	(BTU/hr*Ft2°F)	0.21	0.026	0.13

\*U-frame values estimated based on PHIUS Certified frame performances for 725 Series windows with 7H glass, as frame construction is identical across all window series, frame values are identical. See also 725 certificates at end of this submittal packet.

\*\*Ψ<sub>spacer</sub> values estimated based on default psi-spacer in PHPP simulation software for glass with stainless steel spacers.

\*\*\*Center of glass performances based on modeling in Window 7 using EN673 environmental conditions and gas libraries.

## TUBELITE®



### Product

#### Performance Requirements

Air infiltration shall not exceed .30 CFM/Ft<sup>2</sup> when tested in accordance with ASTM E-283 at a test pressure of 1.60 PSF. Actual test result was .30 CFM/Ft<sup>2</sup>.\*

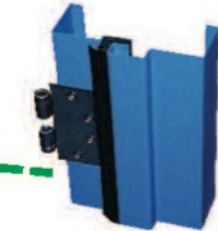
There shall be no uncontrolled water entry when tested in accordance with ASTM E-331 "Water Penetration of Exterior Windows, Curtainwalls and Doors by Uniform Static Air Pressure Difference" at a test pressure of 0 PSF.

Thermal transmittance due to conduction ( $U_c$ ) shall not be greater than .651 - thermal strut, BTU/Hr/Ft<sup>2</sup>/F degree when tested in accordance with AAMA 1503-98. Condensation Resistance Factor (CRF) shall not be less than 56 - thermal strut, when tested in accordance with AAMA 1503-98.

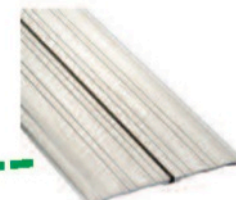


Ceco Door  
Trio-E Insulated Steel Stiffened Door

Ceco Door  
Thermal Break Frame



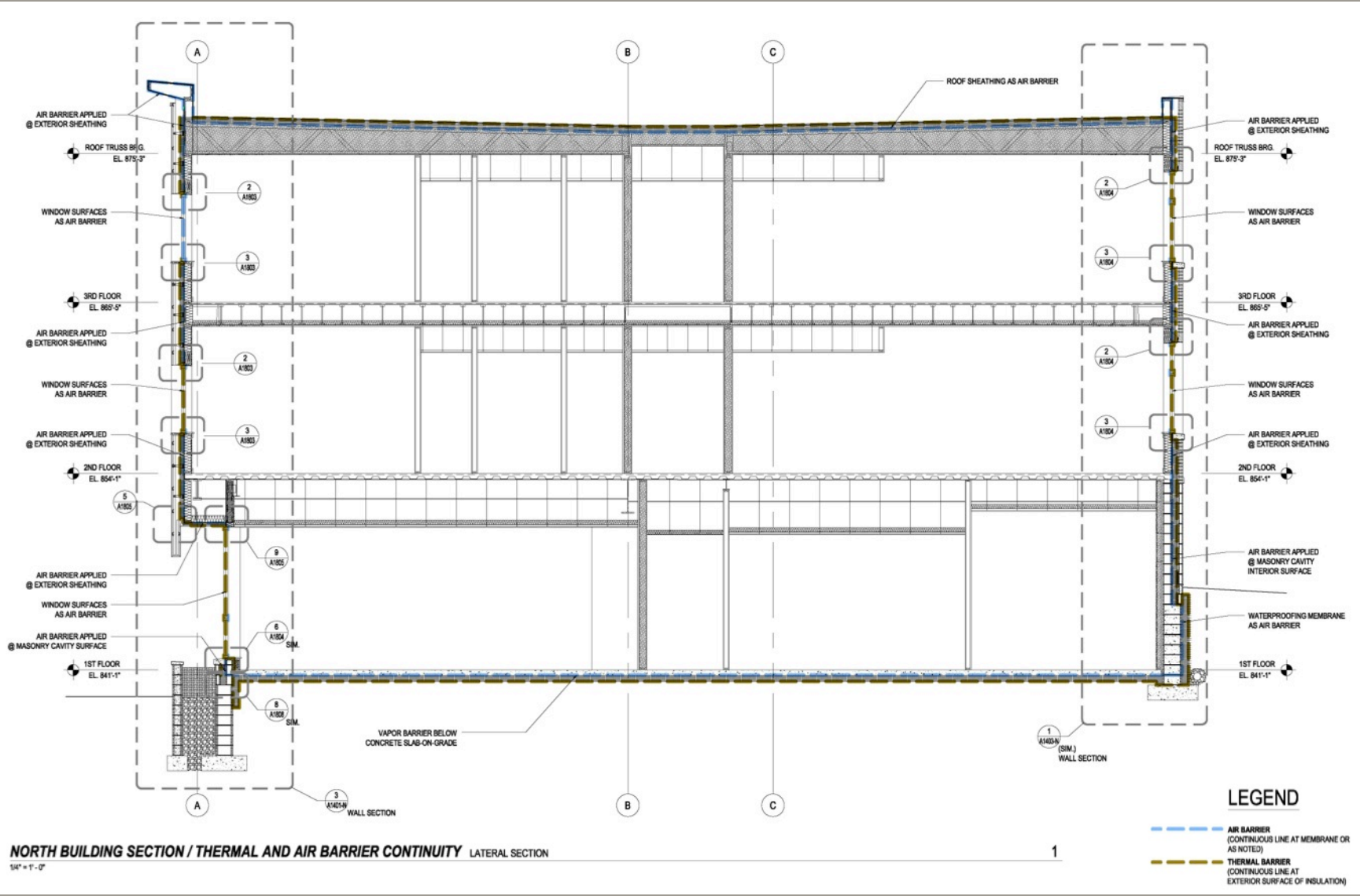
Pemko 273x3AFG  
Thermal Barrier Saddle



### Performance

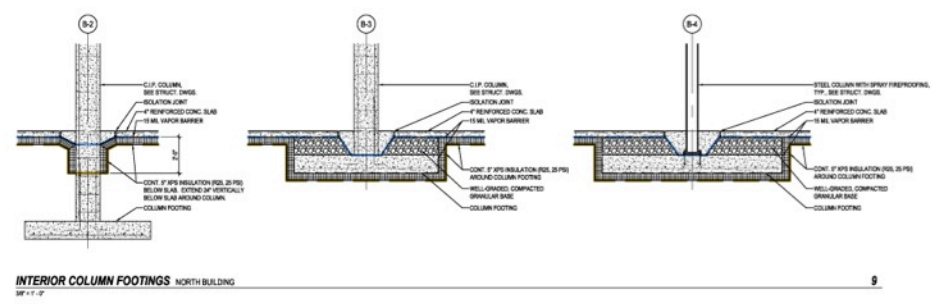
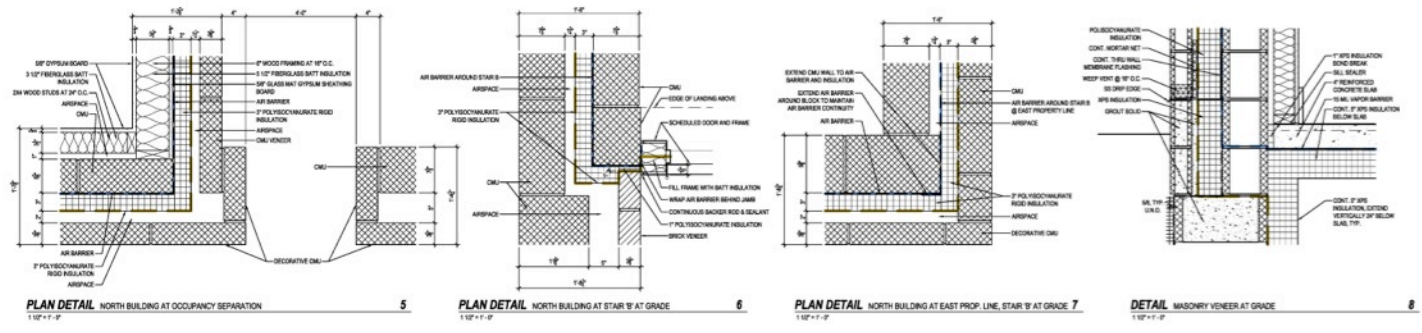
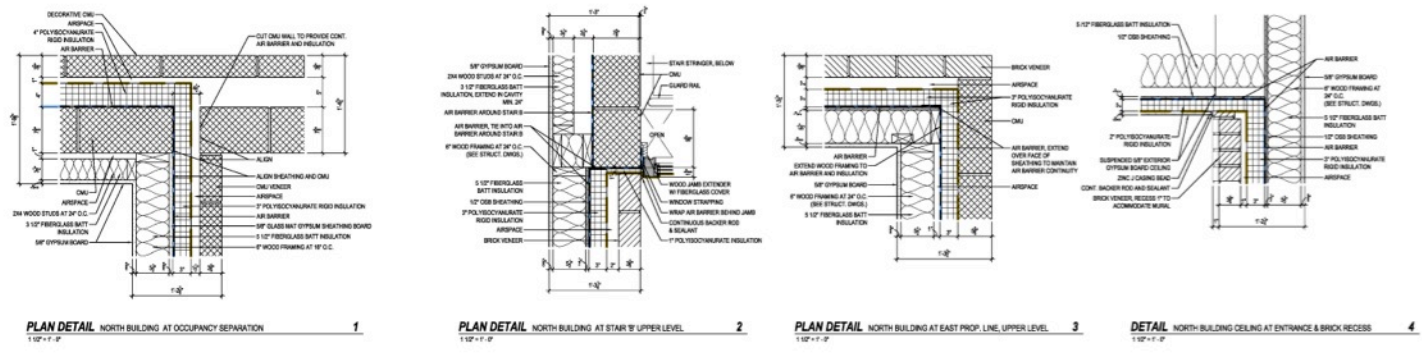
- Thermal Insulation: U-Factor 0.29, R-Value 3.4 (ASTM C1363), For test data regarding ASTM C518 and ASTM E 283, please refer to our website under Energy Efficiency.

## Exterior Doors



# Thermal & Air Barrier Continuity Drawings

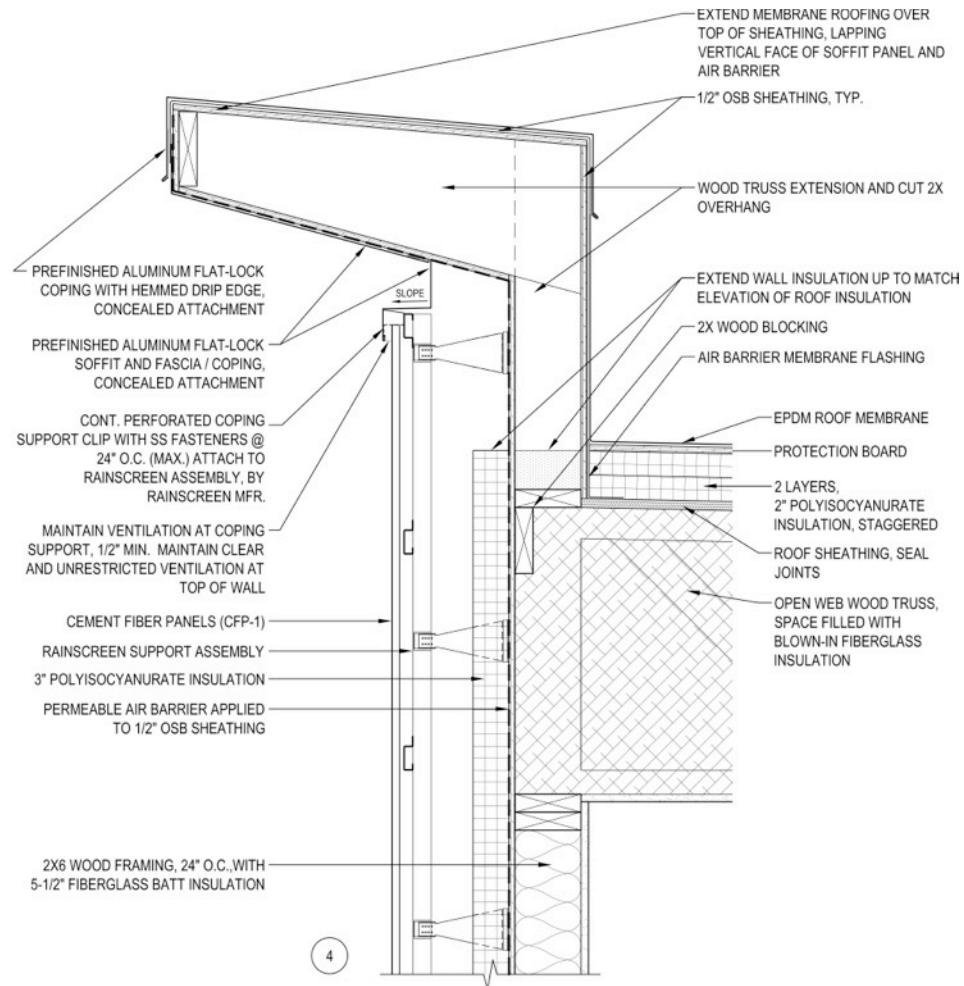
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**INTERIOR COLUMN FOOTINGS** NORTH BUILDING  
1/2" = 1'-0"

# Thermal & Air Barrier Continuity Details

Designing and Constructing a High-Performance Building Envelope for Multi-Unit Affordable Housing



## Fiber Cement Rainscreen – Parapet Wall



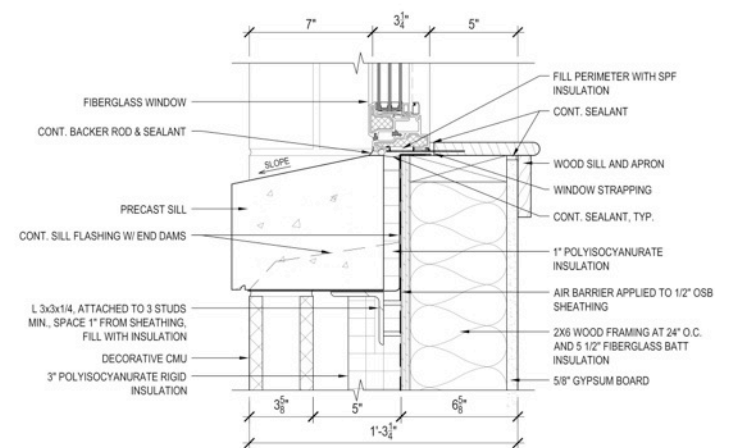
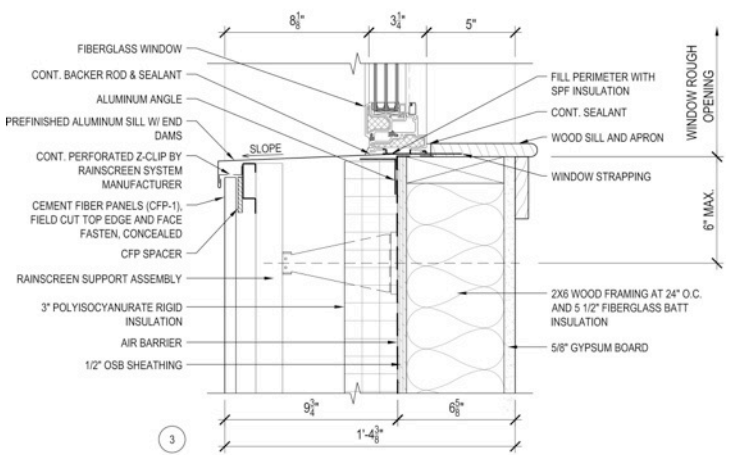
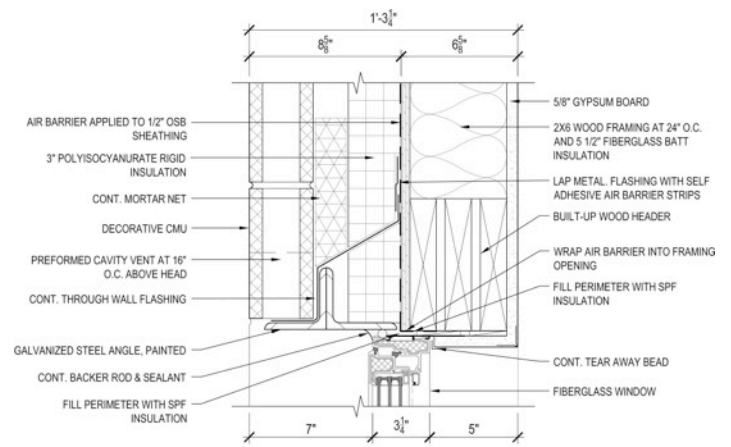
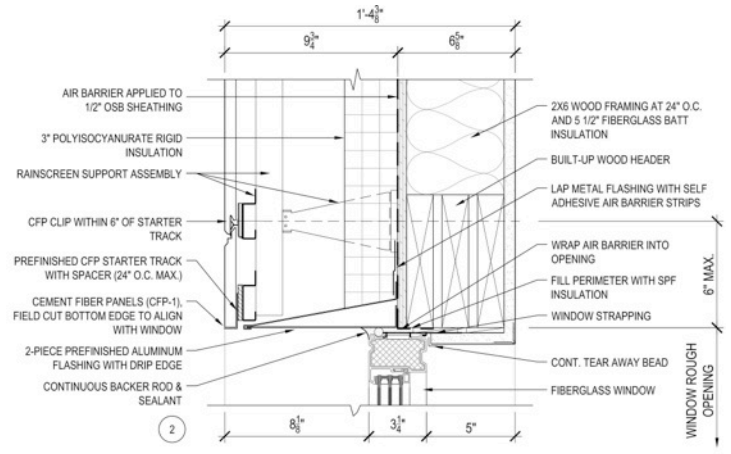


Parapet Wall



Parapet Wall

Designing and Constructing Multi-Unit Housing as a Comparison for Envelope Performance and Energy Savings

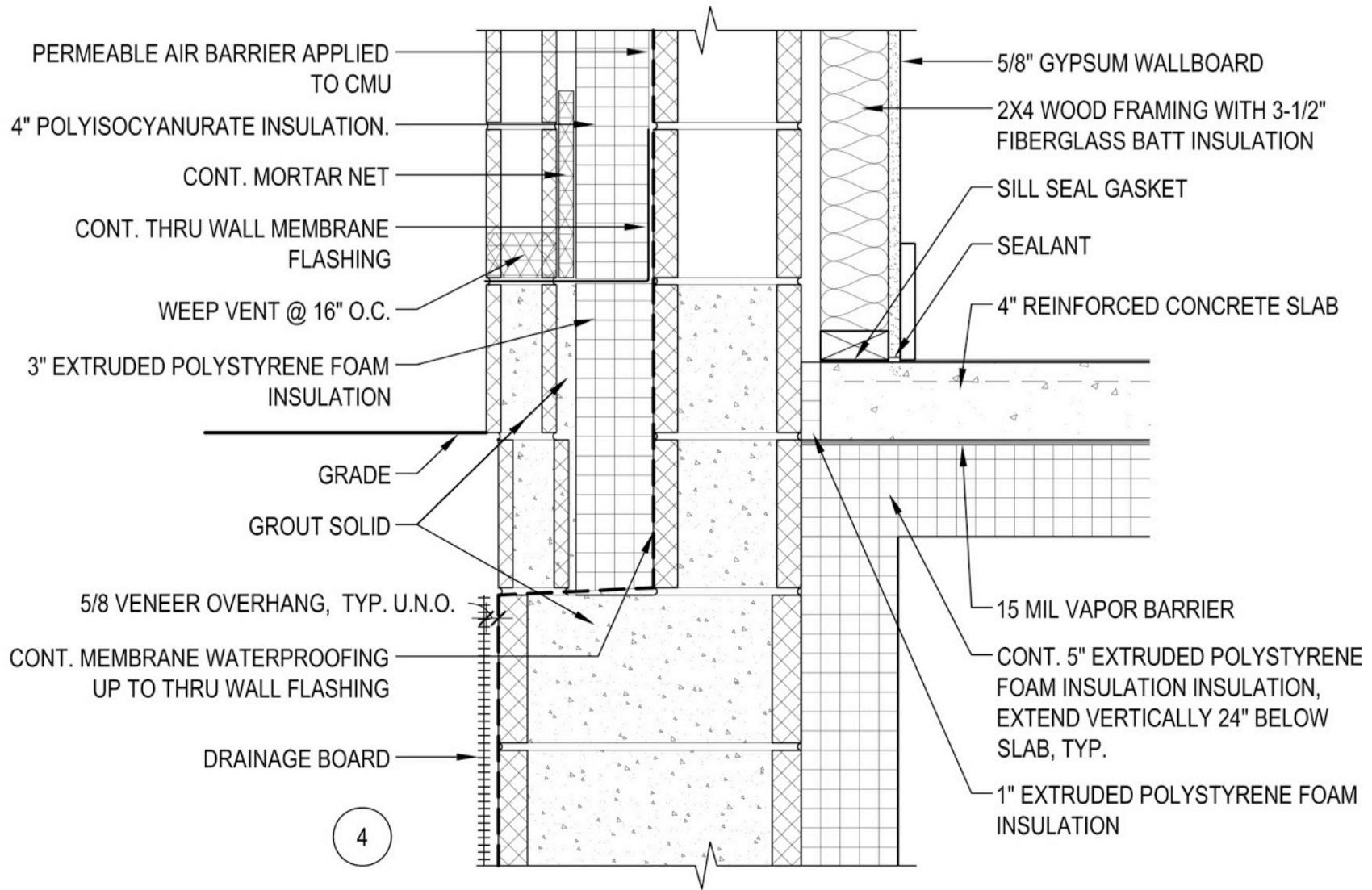


# Window Details



## Windows

Designing and Constructing Multi-Unit Housing as a Comparison for Envelope Performance and Energy Savings



### Wall Construction Transition at Grade



Wall Construction Transition at Grade

Designing and Constructing Multi-Unit Housing as a Comparison for Envelope Performance and Energy Savings



Wall Construction Transition at Grade

Designing and Constructing Multi-Unit Housing as a Comparison for Envelope Performance and Energy Savings



### Properties of Fabreeka's Thermal Insulation Material

Mechanical Properties			
Tensile Strength	PSI	ASTM D638	9,400
Flexural Strength	PSI	ASTM D790	22,300
Compressive Strength	PSI	ASTM D695	38,900
Compressive Modulus	PSI	ASTM D695	1,450,377
Shear Strength	PSI	ASTM D732	13,400
Thickness	in	-	1/4", 1/2", 1"

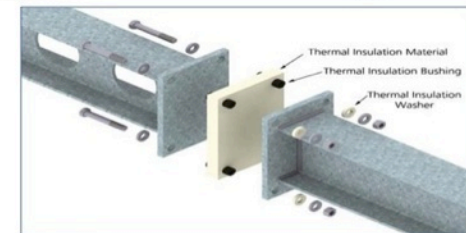
Flame Resistance			
Oxygen Index	%O <sub>2</sub>	ASTM D2863	21.8

Thermal Properties			
Coefficient of Thermal Expansion	in/in/°C x 10 <sup>-5</sup>	ASTM D696	2.2
Thermal Conductivity	BTU/Hr/ft <sup>2</sup> /in/°F W/m*K	ASTM C177	1.8** 0.259

\*\*Reference: Thermal Conductivity of Steel

BTU/Hr/ft <sup>2</sup> /in/°F W/m*K	374.5 54.0
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### Additional Products for Building & Construction



<b>World Headquarters</b> <b>Fabreeka International, Inc.</b> PO Box 210 1023 Turppike Street Stoughton, MA 02072 Tel: (800) 322-7352 Tel: (781) 341-3655 Fax: (781) 341-3983 E-mail: <a href="mailto:info@fabreeka.com">info@fabreeka.com</a> <a href="http://www.fabreeka.com">www.fabreeka.com</a>	<b>Canada</b> <b>Fabreeka Canada Ltd</b> Tel: (800) 322-7352 Fax: (781) 341-3983 E-mail: <a href="mailto:info@fabreeka.com">info@fabreeka.com</a> <a href="http://www.fabreeka.ca">www.fabreeka.ca</a>	<b>Germany</b> <b>Fabreeka GmbH Deutschland</b> Hessenring 13 D-64572 Büttelborn Tel: 49 - (0)6152-9597-0 Fax: 49 - (0)6152-9597-40 E-mail: <a href="mailto:info@fabreeka.de">info@fabreeka.de</a> <a href="http://www.fabreeka.de">www.fabreeka.de</a>	<b>England</b> <b>Fabreeka International, Inc.</b> 8 - 12 Jubilee Way Thackley Old Road, Shipley West Yorkshire BD18 1QG Tel: 44 - (0)1274 531333 Fax: 44 - (0)1274 531717 E-mail: <a href="mailto:info@fabreeka-uk.com">info@fabreeka-uk.com</a> <a href="http://www.fabreeka.co.uk">www.fabreeka.co.uk</a>	<b>Taiwan</b> <b>Fabreeka International, Inc.</b> PO Box 1246 Tainan 70499 Taiwan Tel: 886-935 273732 E-mail: <a href="mailto:info@fabreeka.tw">info@fabreeka.tw</a> <a href="http://www.fabreeka.com.cn">www.fabreeka.com.cn</a>
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Thermal Isolation of Exterior Structure

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# PHPP Model - Precertification:

## **Continued Development of PHPP Model:**

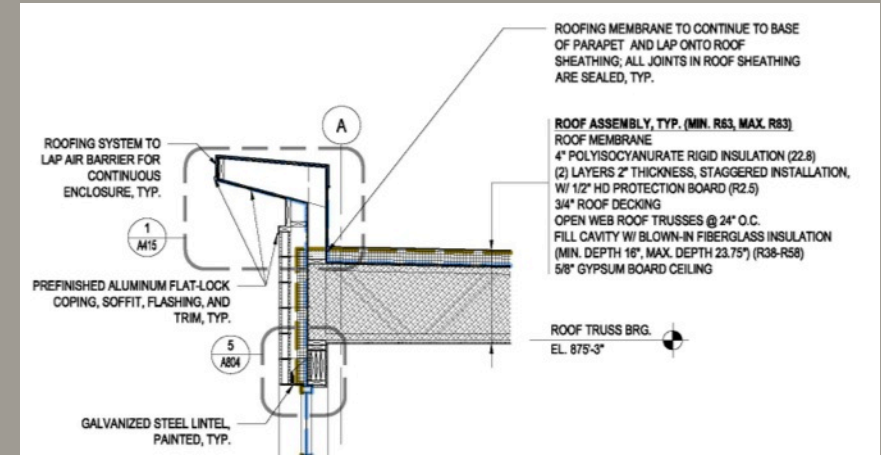
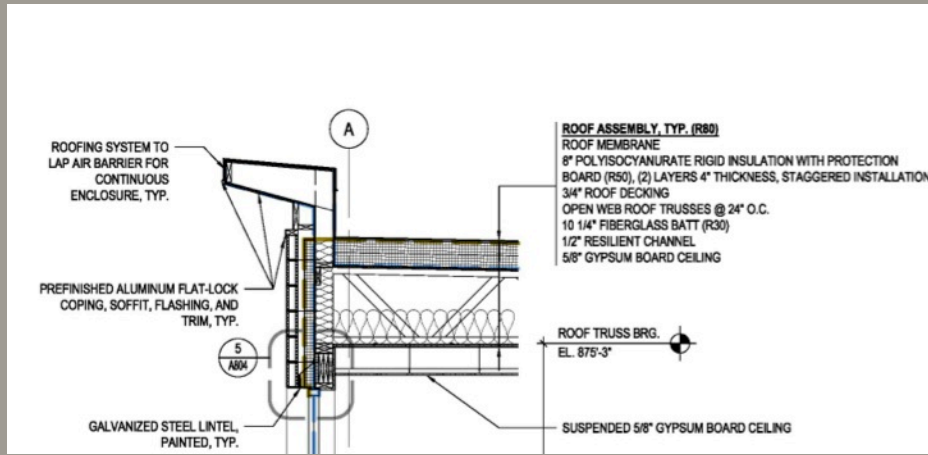
- Building Enclosure Design Finalized
- CPHC continued to generate & update data related to Primary Energy & Internal Gains (Shading Analysis, Lighting & Plug Load calculations, Internal Heat Gains from equipment)

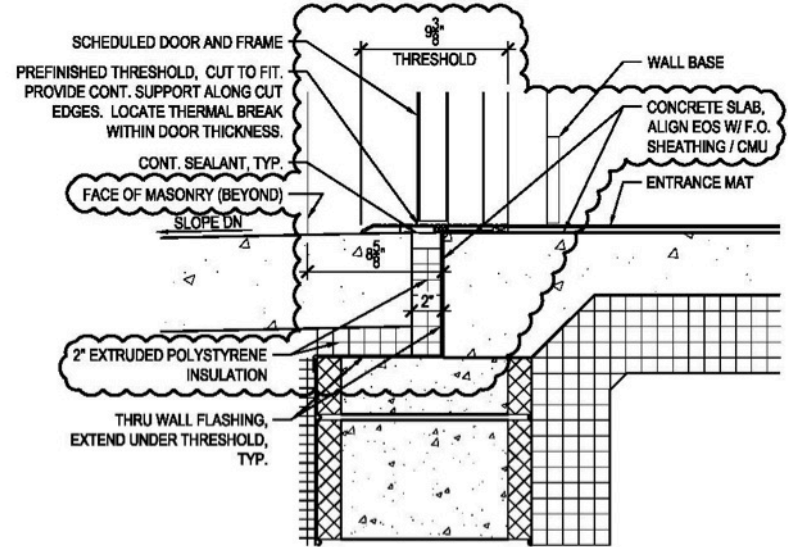
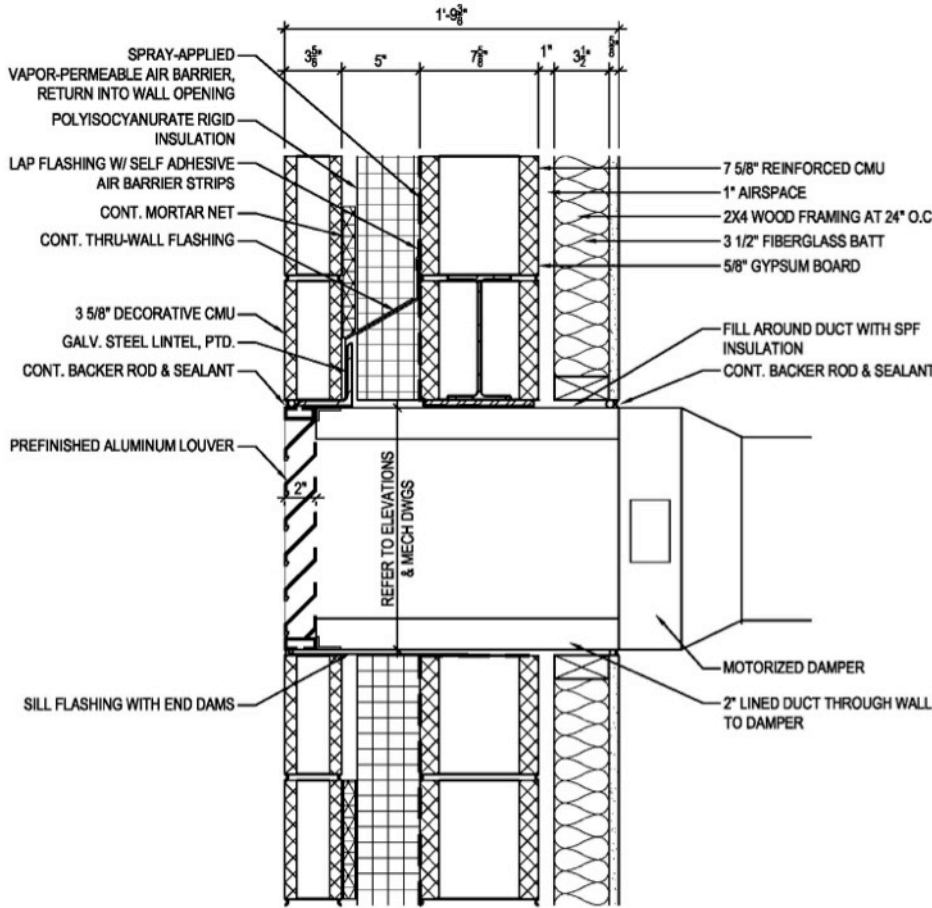
## **PHIUS+ Precertification:**

- Design finalized in PHPP model, however mechanical submittal data still needed before Precertification could be given
- Precertification received 6-months into construction
- Most other product data submittals received by this time and incorporated into the PHPP model
- Roof Insulation construction change also incorporated

## Roof Insulation:

- NFPA-13 compliance required filling the concealed roof truss space with non-combustible insulation.
- Original Design – 8” polyisocyanurate insulation (R-50) outboard of roof sheathing + 10-1/2” fiberglass batt insulation between trusses (R-30)
- Revised Design – 4” polyisocyanurate insulation (R-25) outboard of roof sheathing + truss space filled with blown-in fiberglass insulation (R48 average)
- Air- and vapor-control insulation (polyisocyanurate) close to < 35% of total assembly, PHIUS required a WUFI modeling to confirm that the mold/moisture risk to the assembly was acceptable low





### Additional Critical Details

# Specified Construction Requirements:

## **014000 Quality Requirements**

- PHIUS+ and Energy Star requirements & checklists
- Outline of anticipated tests & inspections
- Exterior Wall Mockup

## **072700 Building Enclosure Air Sealing:**

- Air Sealing Representative
- Air Sealing Plan
- Preconstruction Meeting
- Air tightness pre-testing of assemblies
- Delineates specific areas required to be air sealing
- Penetrations between areas being tested for air leakage and adjoining interior spaces – refers to 078413 Penetration Firestopping & 079200 Joint Sealant.
- Additional requirements for Residential Unit Compartmentalization?
- Additional requirements for sealing of perimeters and penetrations in interior vapor barriers?

## **079200 Joint Sealants:**

- Air sealing products



Exterior Wall Mockup

Designing and Constructing Multi-Unit Housing as a Comparison for Envelope Performance and Energy Savings

## ENERGY STAR v3.0 Home Verification Summary

**Property**  
Action Housing  
2076 Fifth Avenue  
Pittsburgh, PA 15219

**Organization**  
Building Performance Arch.  
(412)441-1075  
Eric Gambal


**HERS**  
Projected Rating  
11/13/13  
Rating No:13007  
Rater ID:GWS245

**Builder**  
Weather:Pittsburgh, PA  
Uptown Lofts on Fifth-North Bldg  
131113 Unit 2L.blg

**HERS  
Index = 69**

**Projected Rating: Based on Plans - Field Confirmation Required.**

Building Information		Rating	
Conditioned Area (sq ft)	627	HERS Index	69
Conditioned Volume (cubic ft)	5142	HERS Index w/o PV	69
Insulated Shell Area (sq ft)	1953	HERS Index Target (SAF Adjusted)	78
Number of Bedrooms	1	HERS Index of Reference Design Home	78
Housing Type	Apartment, end unit	Size Adjustment Factor	1.00
Foundation Type	Unconditioned basement		

 This home **MEETS OR EXCEEDS** the EPA's requirements for an ENERGY STAR Home.  
HERS Index w/o PV <= HERS Index of Reference Design Home AND HERS Index <= HERS Index Target to comply.

### Building Shell

Ceiling w/Attic	None	Window Type	DbL/LoE/Arg - UTNF
Sealed Attic	None	Window	U-Value: 0.130, SHGC: 0.560
Vaulted Ceiling	None	Window/Wall Ratio	0.22
Above Grade Walls	R-44-brick U=0.024	Infiltration Type	Blower door test
Found. Walls(Cond)	None	Infiltration	Htg: 0.60 Clg: 0.60 ACH50
Found. Walls(Uncond)	R-38 U=0.034	Duct Leakage to Outside	25.00 CFM @ 25 Pascals
Frame Floors	R-38 U=0.034	Total Duct Leakage	50.00 CFM @ 25 Pascals
Slab Floors	None		

### Mechanical Systems

Water Heating	Conventional, Elec, 0.96 EF.
ASHP	Htg: 13.5 kBtu/h, 10.4 HSPF. Clg: 12.0 kBtu/h, 17.6 SEER.
Programmable Thermostat	Heat=Yes; Cool=Yes
Ventilation System	Balanced: ERV, 21 cfm, 48.0 watts.

### Lights and Appliances

Percent Interior Lighting	100.00	Clothes Dryer Fuel	Electric
Percent Garage Lighting	0.00	Clothes Dryer EF	3.01
Refrigerator (kWh/yr)	383.00	Clothes Washer LER	704.00
Dishwasher kWh/yr	0	Clothes Washer Capacity	2.87
Ceiling Fan (cfm/Watt):	128.00	Range/Oven Fuel	Electric

Note: Where feature level varies in home, the dominant value is shown.

REM/Rate - Residential Energy Analysis and Rating Software v14.3  
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**BUILDING PERFORMANCE ARCHITECTURE**

## 2009 IECC Building UA Compliance

**Property**  
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Pittsburgh, PA 15219

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**HERS**  
Projected Rating  
11/13/13  
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**Builder**  
Weather:Pittsburgh, PA  
Uptown Lofts on Fifth-North Bldg  
131113 Unit 2L.blg

Elements	Insulation Levels	
	2009 IECC	As Designed
Shell UA Check		
Above-Grade Walls:	12.2	5.1
Windows and Doors:	21.7	8.0
Floors Over Uncond Basement:	20.7	21.4
Overall UA (Design must be equal or lower):	54.6	34.5
Window U-Factor Check (Section 402.5)		
Window U-Factor (Design must be equal or lower):	0.480	0.130

This home **MEETS** the overall thermal performance requirements and verifications of the International Energy Conservation Code based on a climate zone of 5A. (Section 402, International Energy Conservation Code, 2009 edition.) In fact, this home surpasses the requirements by 36.7%.

Building Elements	Type	U-Value	Area
Above-Grade Walls			
Wall	R-44-brick	0.024	78.0
Wall	R-44-brick	0.024	136.1
Wall	Uninsulated Stud	0.267	247.0
Wall	Uninsulated Stud	0.267	156.0
Windows and Doors			
Window	DbL/LoE/Arg - UTNO	0.130	12.0
Window	DbL/LoE/Arg - UTNF	0.130	22.0
Window	DbL/LoE/Arg - UTNO	0.130	12.0
Window	DbL/LoE/Arg - UTNF	0.130	10.6
Window	DbL/LoE/Arg - UTNO	0.130	5.3
Door	2-1/4 Wd solid core	0.268	20.0
Floors Over Uncond. Basement			
Floor	R-38	0.034	627.0

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**BUILDING PERFORMANCE ARCHITECTURE**

This home **MEETS** the overall thermal performance requirements and verifications of the International Energy Conservation Code based on a climate zone of 5A. (Section 402, International Energy Conservation Code, 2009 edition.) In fact, this home surpasses the requirements by 36.7%.

# Preconstruction Meeting :

## **Rater:**

- Summary of PHIUS+ and all partner certification requirements, testing & inspections
- Schedule of Inspections & Testing relative to construction sequence

## **Architect:**

- PHIUS+ Thermal & Air Barrier Continuity Drawings
- Areas requiring special air sealing, verification required in air barrier shop drawings

## **Constructor:**

- Air Sealing Representative & Air Sealing Plan
- Schedule of Inspections incorporated in the critical path project schedule

## **Subcontractors:**

- Only those involved with the exterior enclosure attended; Mechanical, Plumbing & Electrical Contractors should be included

1. **(Optional)** Lead a preconstruction meeting, for a maximum of four (4) hours, to familiarize the Contractor's staff and subcontractors with the inspection and testing processes, as well as ways to meet the requirements of PHIUS, ENERGY STAR Homes, EPA Indoor Air Plus, and DOE Challenge Home, for this project.



**BUILDING  
PERFORMANCE  
ARCHITECTURE**



417 GETTYSBURG STREET PITTSBURGH, PA 15206 412 - 441 - 1075 P 412 - 363 - 5315 F [www.buildperformarch.com](http://www.buildperformarch.com)

## **Uptown Lofts**

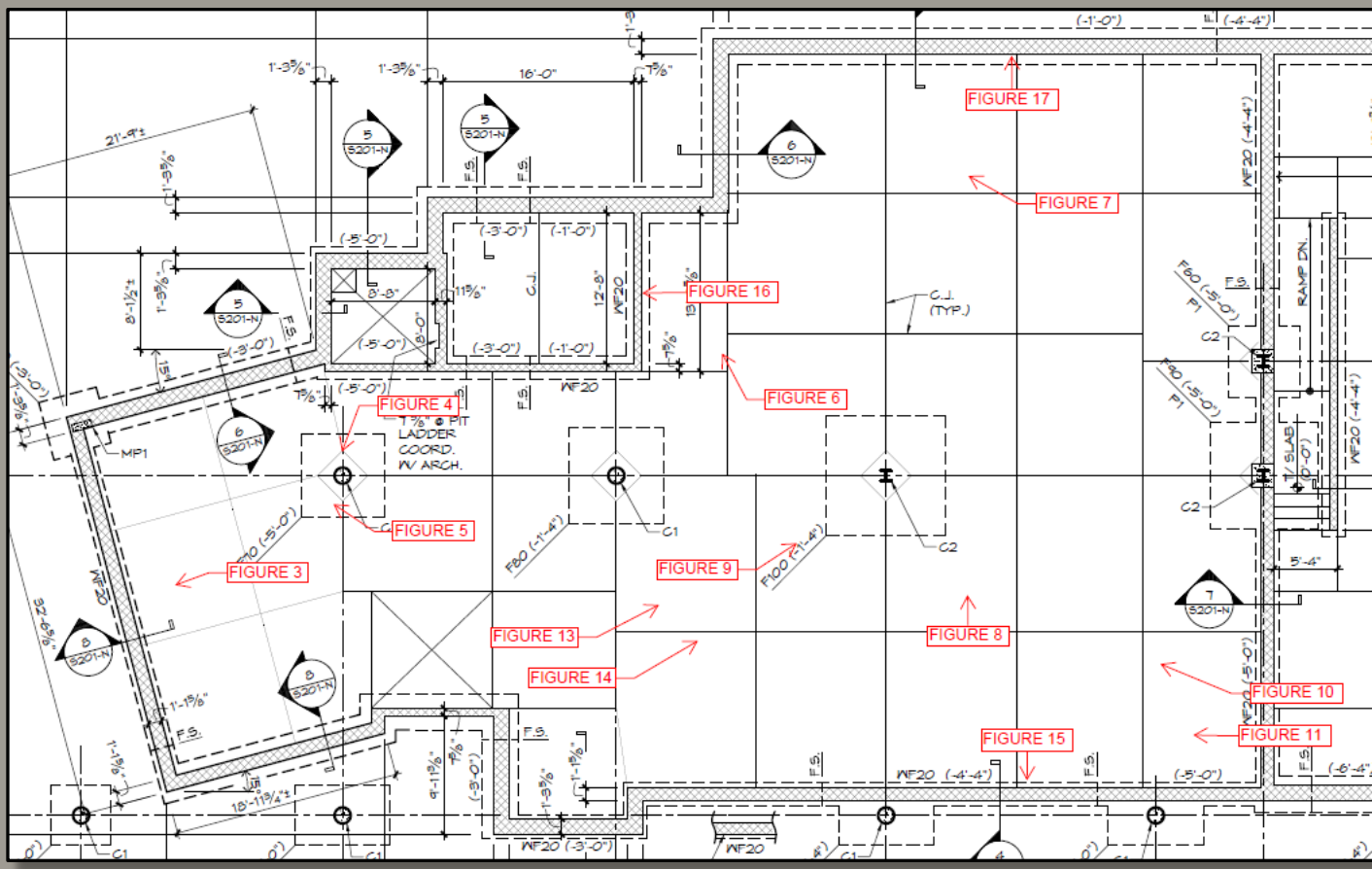
### **ENERGY STAR Homes & PHIUS+ Testing & Inspection Contractor Orientation Meeting**

June 10, 2014

Purpose of Meeting: Familiarize the Contractor and subcontractors with the inspection and testing processes, as well as ways to meet the requirements....:

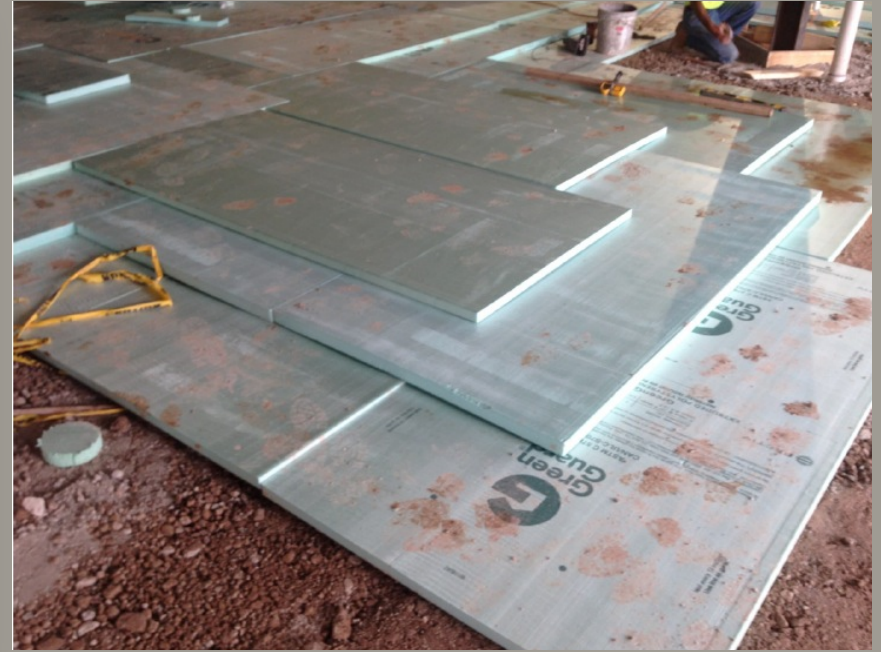
(North Building): of PHIUS, ENERGY STAR Homes, EPA Indoor Air Plus, and DOE Challenge Home, for this project.





### Insulation Verification

Designing and Constructing a High-Performance Building Envelope for Multi-Unit Affordable Housing



## Insulation Verification

Designing and Constructing a High-Performance Building Envelope for Multi-Unit Affordable Housing



## Insulation Verification

Designing and Constructing a High-Performance Building Envelope for Multi-Unit Affordable Housing



## Insulation Verification

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## Preliminary Blower Door Test

Designing and Constructing a High-Performance Building Envelope for Multi-Unit Affordable Housing



Preliminary Blower Door Test

Designing and Constructing a High-Performance Building  
Envelope for Multi-Unit Affordable Housing



Air Sealing at Interior Framing

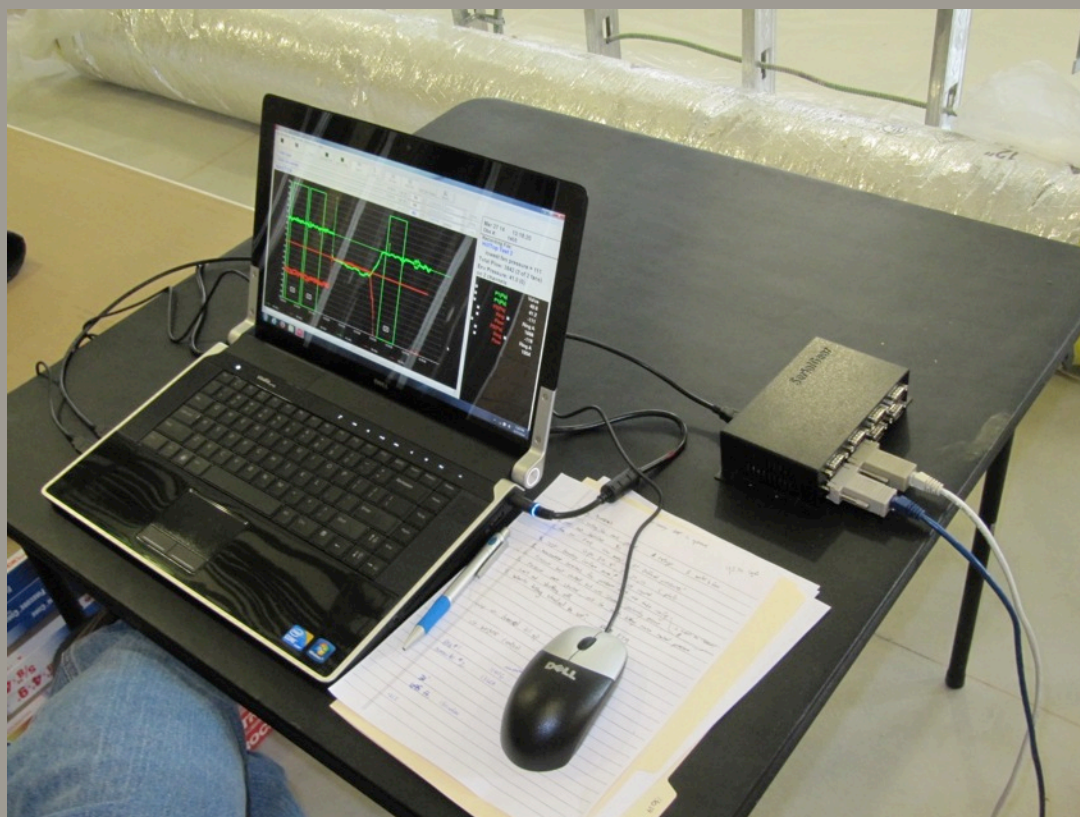


Blower Door Testing



Designing and Constructing a High-Performance Building Envelope for Multi-Unit Affordable Housing





## Blower Door Testing

Designing and Constructing a High-Performance Building Envelope for Multi-Unit Affordable Housing



## Building Enclosure Construction Sequencing

Designing and Constructing a High-Performance Building Envelope for Multi-Unit Affordable Housing



## Building Enclosure Construction Sequencing

Designing and Constructing a High-Performance Building Envelope for Multi-Unit Affordable Housing

# Project Closeout:

## **The Home Stretch - Can It All Happen At Once?**

1. Full building blower door test (retakes)
2. Occupancy Permit inspections
3. Energy code compliance verification
4. Punch List inspections and repairs
5. HVAC Contractor testing & balancing
6. Other Rater inspections, tests & checklists completion (including blower door test in units)
7. Contractor checklists (responses to Raters earlier Inspection comments, including photographic records)
8. HVAC contractor's (and HVAC engineer's) checklist completion
9. Contractor's Declaration (verification & documentation of as-built details)



## Residential Unit Blower Door Testing

Designing and Constructing a High-Performance Building Envelope for Multi-Unit Affordable Housing



## Hunting for Air Leakage

Designing and Constructing a High-Performance Building Envelope for Multi-Unit Affordable Housing



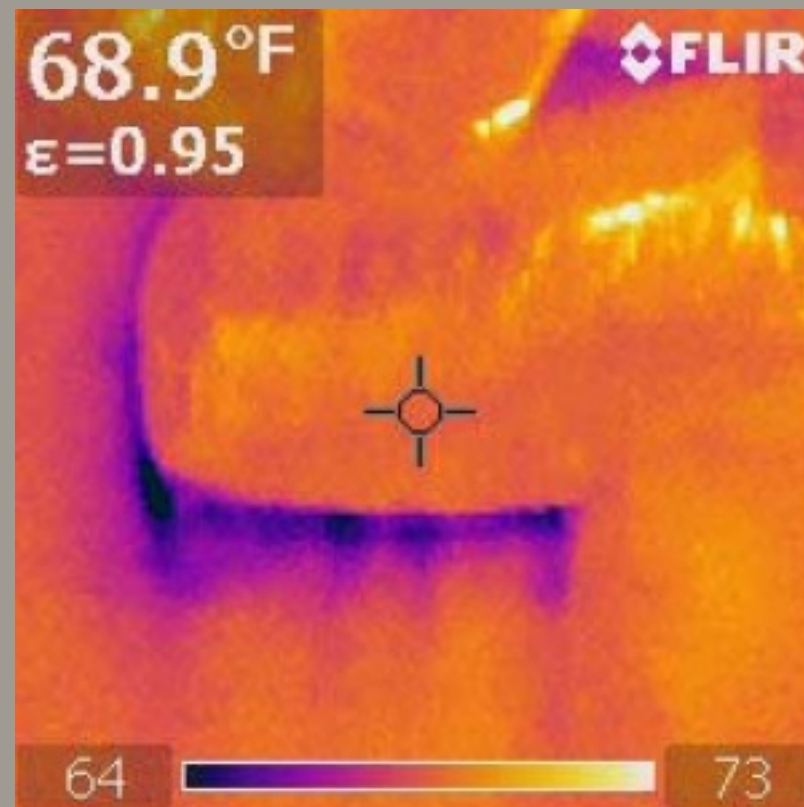
## Hunting for Air Leakage

Designing and Constructing a High-Performance Building Envelope for Multi-Unit Affordable Housing



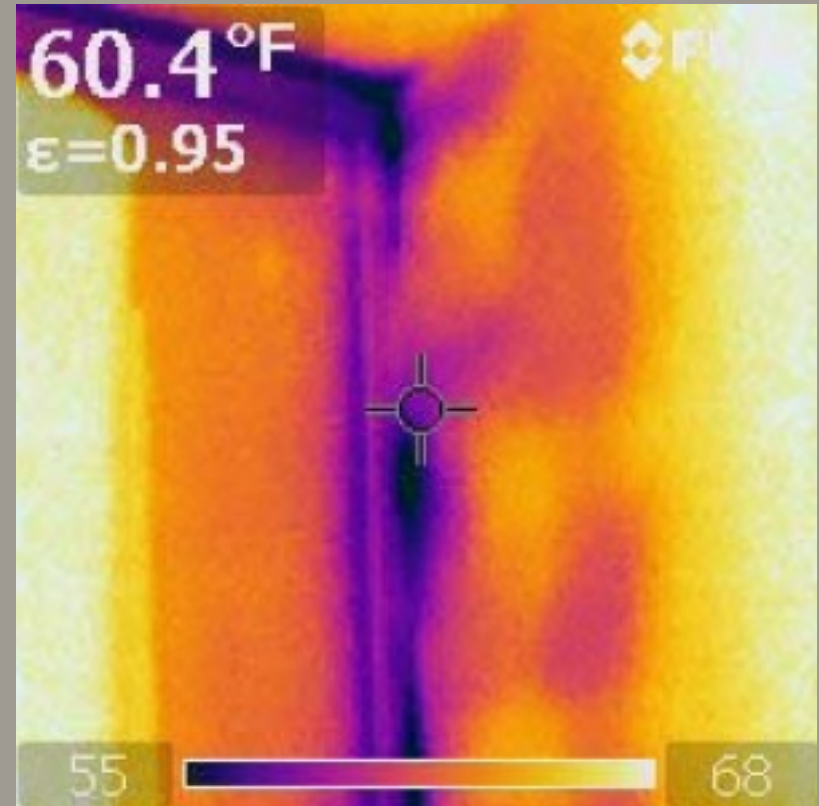
Hunting for Air Leakage





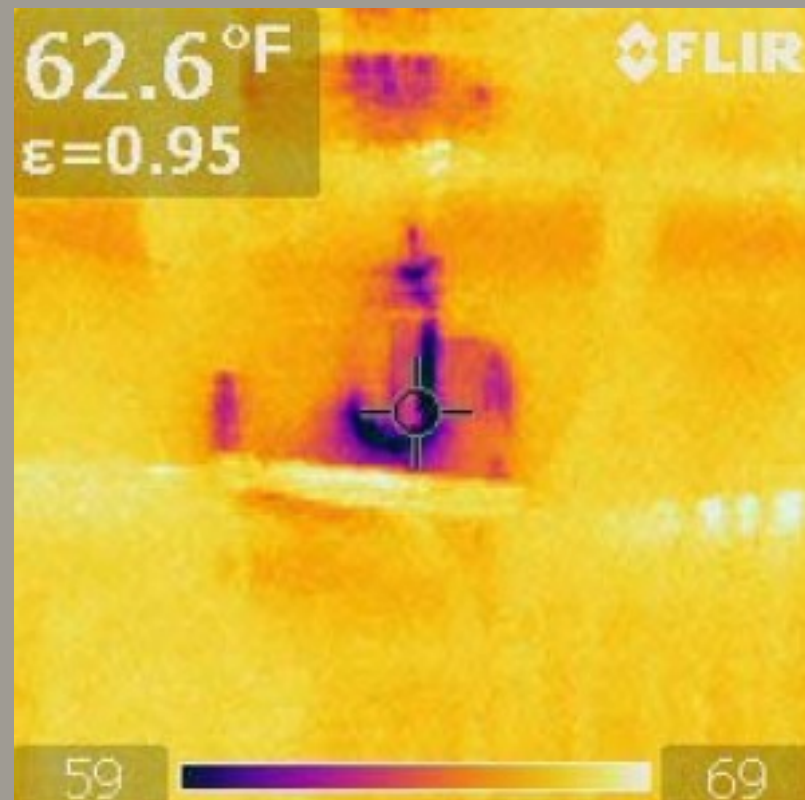
## Hunting for Air Leakage

Designing and Constructing a High-Performance Building Envelope for Multi-Unit Affordable Housing



## Hunting for Air Leakage

Designing and Constructing a High-Performance Building Envelope for Multi-Unit Affordable Housing



## Hunting for Air Leakage

Designing and Constructing a High-Performance Building Envelope for Multi-Unit Affordable Housing



## Hunting for Air Leakage

Designing and Constructing a High-Performance Building Envelope for Multi-Unit Affordable Housing

## Updating the PHPP Model:

- From the Rater's test results, all checklists, and the Contractor's Declaration, PHIUS updated the PHPP model and confirmed Certification.
- For the Uptown Lofts this was limited to the Air Tightness and ERV unit power measurements.
- The Contractor's Declaration, requires the Contractor to certify that the as built building matches the PHPP model and all details submitted to PHIUS. The Rater was not required to confirm the accuracy of all data in the PHPP model, as all the Rater inspections and tests are intended to provide this same confirmation.

## Updating the REM/Rate Models:

- The Rater updated their REM/Rate model(s) with their test data.
- Greater air and duct leakage raised the unit HERS index to 70. After extensive optimization of the model data, the final unit HERS index is 60.

## Project Close-Out

## ENERGY STAR v3.0 Home Verification Summary

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Action Housing  
2076 Fifth Avenue  
Pittsburgh, PA 15219

**Organization**  
Building Performance Arch.  
(412)441-1075  
Eric Gambal

**HERS**  
Confirmed  
5/22/15  
Rating No:13007  
Rater ID:3814298

**Weather:**Pittsburgh, PA  
Uptown Lofts on Fifth-North Bldg  
150522 REM v14\_6 Unit 2L\_Energy  
Star Washer.blg

**Builder**  
Mosites Construction Company

**Confirmed: - No Registry ID**

### Building Information

Conditioned Area (sq ft) 690  
Conditioned Volume (cubic ft) 6670  
Insulated Shell Area (sq ft) 2760  
Number of Bedrooms 1  
Housing Type Apartment, end unit  
Foundation Type Open crawl space/raised floor

### Rating

HERS Index 60  
HERS Index w/o PV 60  
HERS Index Target (SAF Adjusted) 79  
HERS Index of Reference Design Home 79  
Size Adjustment Factor 1.00

**HERS  
Index = 60**

This home MEETS OR EXCEEDS the EPA's requirements for an ENERGY STAR Home.  
HERS Index w/o PV <= HERS Index of Reference Design Home AND HERS Index <= HERS Index Target to comply.

### Building Shell

Ceiling w/Attic None	Window Type Dbl /LoE/Arg - UTRF*
Sealed Attic None	Window U-Value: 0.130, SHGC: 0.500
Vaulted Ceiling None	Window/Wall Ratio 0.20
Above Grade Walls R-44-brick*** U=0.023	Infiltration Type Blower door test
Found. Walls(Cond) None	Infiltration Htg: 322 Ctg: 322 CFM50
Found. Walls(Uncond) None	Duct Leakage to Outside 40.00 CFM @ 25 Pascals
Floors R-38*** U=0.025	Total Duct Leakage 80.00 CFM @ 25 Pascals
Slab Floors None	

### Mechanical Systems

Water Heating Conventional, Elec, 0.96 EF.  
ASHP Htg: 13.5 kBtu/h, 10.4 HSPF. Clg: 12.0 kBtu/h, 17.6 SEER.  
Programmable Thermostat Heat=Yes; Cool=Yes  
Ventilation System Balanced: ERV, 43 cfm, 48.0 watts.

### Lights and Appliances

Percent Interior Lighting 100.00	Clothes Dryer Fuel Electric
Percent Garage Lighting 0.00	Clothes Dryer EF 3.01
Refrigerator (KWh/yr) 383.00	Clothes Washer LER 96.00
Dishwasher Energy Factor 0.46	Clothes Washer Capacity 3.81
Ceiling Fan (cfm/Watt): 128.00	Range/Oven Fuel Electric

Note: Where feature level varies in home, the dominant value is shown.

REM/Rate - Residential Energy Analysis and Rating Software v14.6.1  
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## 2009 IECC Building UA Compliance

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Uptown Lofts on Fifth-North Bldg  
150522 REM v14\_6 Unit 2L\_Energy  
Star Washer.blg

**Builder**  
Mosites Construction Company

### Elements

Shell UA Check  
Above-Grade Walls:  
Windows and Doors:  
Floors Over Ambient:  
Overall UA (Design must be equal or lower):

### Insulation Levels

	2009 IECC	As Designed
Above-Grade Walls:	23.6	9.3
Windows and Doors:	21.7	8.0
Floors Over Ambient:	22.8	17.2
Overall UA (Design must be equal or lower):	68.1	34.5

### Mandatory Requirements

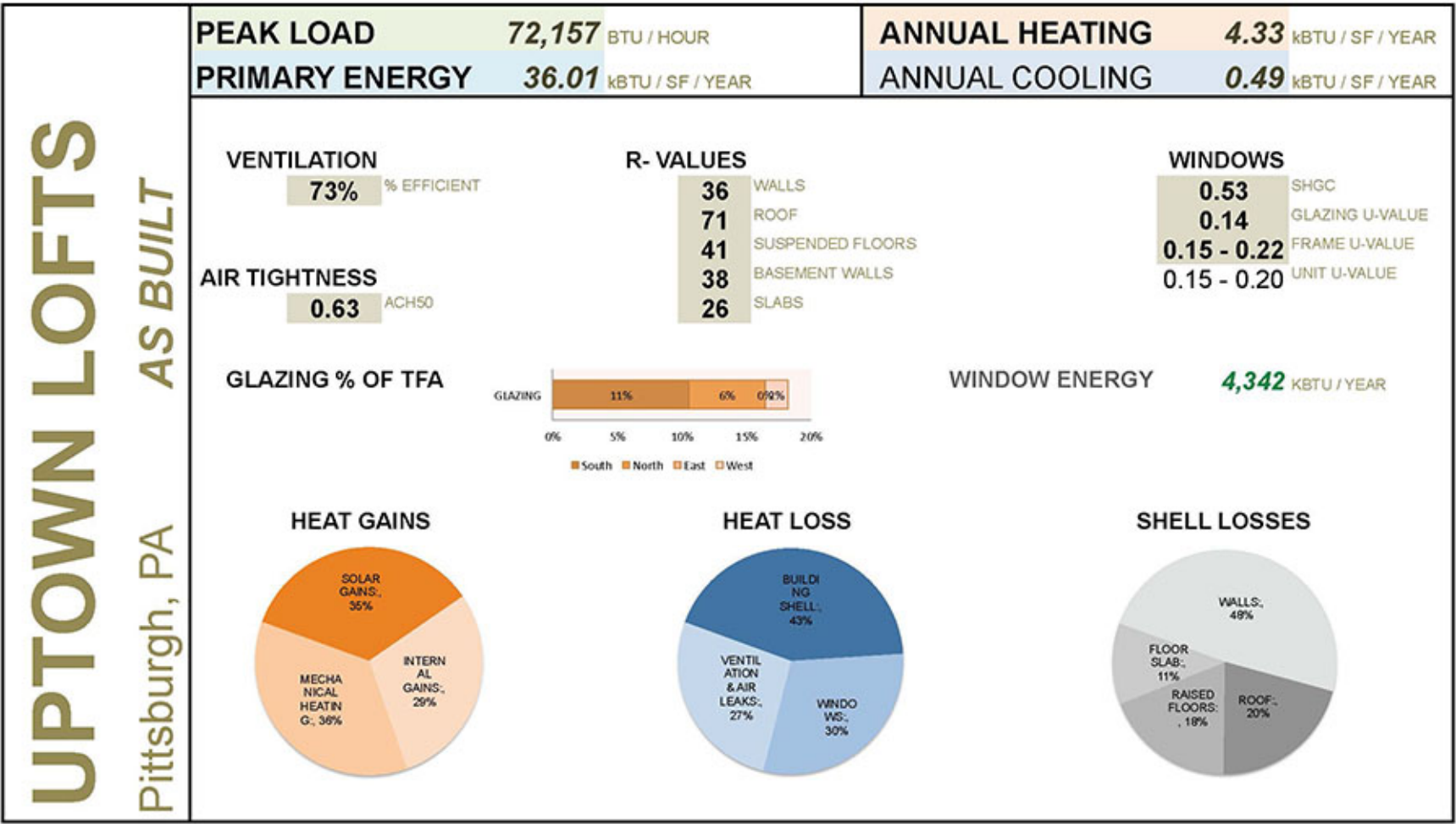
Shell UA Check	PASSES
Duct Insulation R-Value Check (per Section 403.2.1)	PASSES
Window U-Value and SHGC Check (per Section 402.5)	PASSES
Home Infiltration (Section 402.4.2)	PASSES
Duct Leakage (Section 403.2.2)	PASSES
Mandatory Requirements Check Box (IECC 09)	PASSES

This home MEETS the overall thermal performance requirements and verifications of the International Energy Conservation Code based on a climate zone of 5A. (Section 402, International Energy Conservation Code, 2009 edition.) In fact, this home surpasses the requirements by 49.3%.

Name Eric Gambal	Signature
Organization Building Performance Arch.	Date 3 September 2015

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As-Built PHPP Model



Designing and Constructing a High-Performance Building Envelope for Multi-Unit Affordable Housing



[www.fortyeighty.com](http://www.fortyeighty.com)

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Thank you for attending!