SUSTAINABLE COMFORT

Engaging PHIUS Verification in Early Design

From a PHIUS Verifiers Perspective

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Senior Project Manager
Sustainable Comfort, Inc.

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NEW YORK 2021

Learning Objectives

Learning Objective 1: Understand the additional program requirements for PHIUS Certification

Learning Objective 2: Review how checklist programs and feedback can be incorporated into an iterative design process

Learning Objective 3: Review the Energy Star Multifamily milestones and additional modeling criteria

Learning Objective 4: Identify the major items sometimes overlooked in checklist-based energy programs

PHIUS+ Certification Process

Schematic Design: Initial Layout and Systems

Pre-Certification: Approved Modeling and CD's

Construction Inspections: Insulation & Air Sealing Checks

Final Testing: Air Tightness & Commissioning

Certification: Final Certifications

PHIUS+ Certification Process

Schematic Design: Initial Layout and Systems

Pre-Certification: Approved Modeling and CD's

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West Side Homes, Buffalo, NY

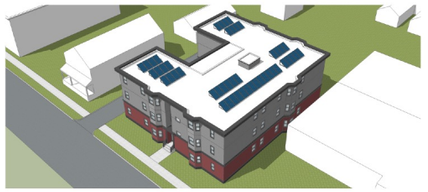
Owner: Buffalo Neighborhood Stabilization Company, Inc.
Design Team Lead: Sustainable Comfort, Inc.

Project Description

The Buffalo Neighborhood Stabilization Company Inc (BNSC), the housing development arm of PUSH Buffalo, proposes to develop 15 units of housing on Buffalo's West Side that is targeting certification with Passive House Institute US (PHIUS), and pursuing NYSERDA, 2020 Enterprise Green Communities, and WELL Building Certification. By coordinating housing and sustainability work, West Side Homes addresses both human and ecosystem health, creates a resilient project that addresses future heat, precipitation, and drought events, and uses renewable energy sources to avoid increased greenhouse gas emissions.

Project Information

Location	Buffalo, NY
Climate Zones	5A
Average HERS Index	<50 pre PV, <10 post PV
Square Footage	18,131 sf
No. of Units	15 Multifamily Units
Year Built	Anticipate 2021 Start



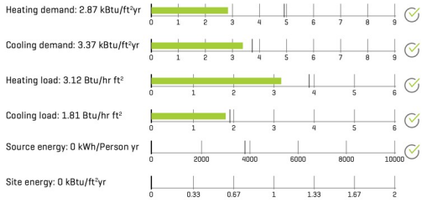
Targeted Certifications

- PHIUS+ 2018 & Source Zero,
- NYSERDA Low Rise New Construction Program Tier III
- 2020 Enterprise Green Communities
- WELL Building Certification

Partners

PUSH BUFFALO
BNSC Buffalo Neighborhood Stabilization Company Inc.
Stieglitz Snyder Architecture
Pathfinder Engineers & Architects
Christa Construction
eco logic studio
Sustainable Comfort

Energy Modeling Results (WUFI Passive)



Technical Details

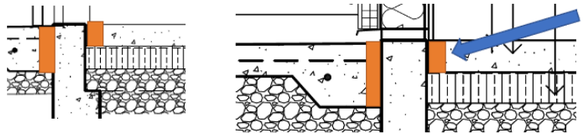
Walls	Wood panelized construction, 2X6 cavity with R-20 dense pack cellulose. Utilizing 2.5" zip panels creating R-12.6 of continuous insulation totaling R-33 exterior wall, finished with LP Smartside.
Windows	Alpen Tyrol Triple Pane Casement Windows
Air Barrier	The exterior ZIP sheathing will create an enhanced air, water, moisture and thermal barrier.
Roof	R-30+ continuous insulation
Slab	Continuous EPS perimeter and under-slab insulation
Heating/Cooling	Ground Source Heat Pump
Ventilation	The ERV ventilation system has monitoring capabilities allowing tenants to track some aspects of indoor air quality.
Hot Water	Geothermal electric hot water with desuperheaters
Solar Electric	Roof-mounted Solar Photovoltaic systems owned by BNSC will produce an estimated 30,755 kWh/yr
Materials	Low carbon materials such as insulation and foam were considered during material selection process.

ENERGY STAR

ZERO
ENERGY READY HOME
U.S. DEPARTMENT OF ENERGY

EPA Indoor airPLUS
QUALIFIED HOME

Design Review

PHIUS+						
66	PHIUS Certification		Mechanical	Exhaust going into return side of common area AHU	**Clarify**	
67	PHIUS Verification		Mechanical	1.3a: All ventilation air inlets located at least 10' ("stretched-string distance") from known contamination sources 1.3b: All ventilation air inlets located minimum 5' from ventilation exhaust outlet, recommended 10' 1.6: Outside air passes through a minimum MERV 8 filter prior to distribution, is changed at final and home is ventilated prior to occupancy 1.7: Outside air filter is located to facilitate regular service by the occupant and/or building superintendent 1.8: Air-sealed, class 1 vapor retarder shall be installed over all air-permeable insulation (such as fiberglass duct wrap) on ventilation ducts connected to outside 1.10: Dedicated Fresh Air supply to all bedrooms Fresh air (OA) supply to bedrooms is required in all dwelling units: • In the case of ventilation ductwork integrated with heating/cooling ducts, the heating/cooling air handler fan must be designed to run continuously by default. **1.14: If kitchen exhaust connected to ERV/HRV, register is min. 6' from cooktop, MERV 3 or washable mesh filter for trapping grease, and recirc hood over range**		
Ceiling/Attic						
68	PHIUS detailing	A-402 RI	Architect	Add notes to spray foam flash layer to air seal above ceiling plan or similar	**Primary air barrier**	
69	WUFI Energy Model	A-402 RI	Architect	Change batts to cellulose and correct R-value	**Need higher R-value for PHIUS modeling**	
70	PHIUS detailing	A-402 RI	Architect	Does poly need to be spec'd at ceiling plane?	**Building science question**	
Walls						
71	PHIUS detailing	A-402 RI & West	Architect	Suggest Prosoco seams of ZIP rather than tape, flash windows with Zip Liquid Flash or Prosoco – At exterior layer		
72	PHIUS detailing	A-402 RI	Architect	Could potentially downgrade ZIP to osb at layer		
73	WUFI Energy Model	A-402 RI	Architect	Model has R-23 batts in 2x6 cavity	**Increase Rhode Island wall cavity insulation value to R-23**	
74	PHIUS detailing	A-402 RI	Architect	Suggest Thermal buck at windows for connections. https://thermalbuck.com/		
75	PHIUS detailing	A-404 RI	Architect	Suggest mid-mounting windows for better psi value	**To avoid any linear thermal bridging we've modeled windows as mid-mounted. Please consider a mid-mounted window.**	
Wall to foundation connection						
76	PHIUS detailing	A-402 RI	Architect	Stop ZIP-R "above grade, connect back to foundation with drip edge and trim to connect to concrete which will become air barrier		
77	PHIUS detailing	A-402 RI	Architect	Add EPS over top air barrier to connect to insulation extending below slab. Then cover EPS exposed above grade.		
78	PHIUS detailing	A-402 RI	Architect	Interior under slab insulation needs to connect to bottom plate. Recommend 4" CMU block with 2" rigid insulation beneath bottom plates can provide detail.		
79	WUFI Energy Model	A-402 RI	Architect	Porch slabs need insulation extending below grade and isolating porch slab from building slab. 		
Wall to roof connection						
80	PHIUS detailing	A-402 RI	Architect	Connect air barrier over ZIP-R to exterior and down.		
81	PHIUS detailing	A-402 RI	Architect	Need to see detail of where flat roof meets pitched roof to detail air barrier connections.		
Certification Programs						
82	EPA IndoorPLUS			Indoor airPLUS low-emitting products documentation	**While it is not necessarily the responsibility of SCI to verify compliance with all the IAP low emitting products requirements, it is necessary for the builder to provide documentation and attestation that all products are**	

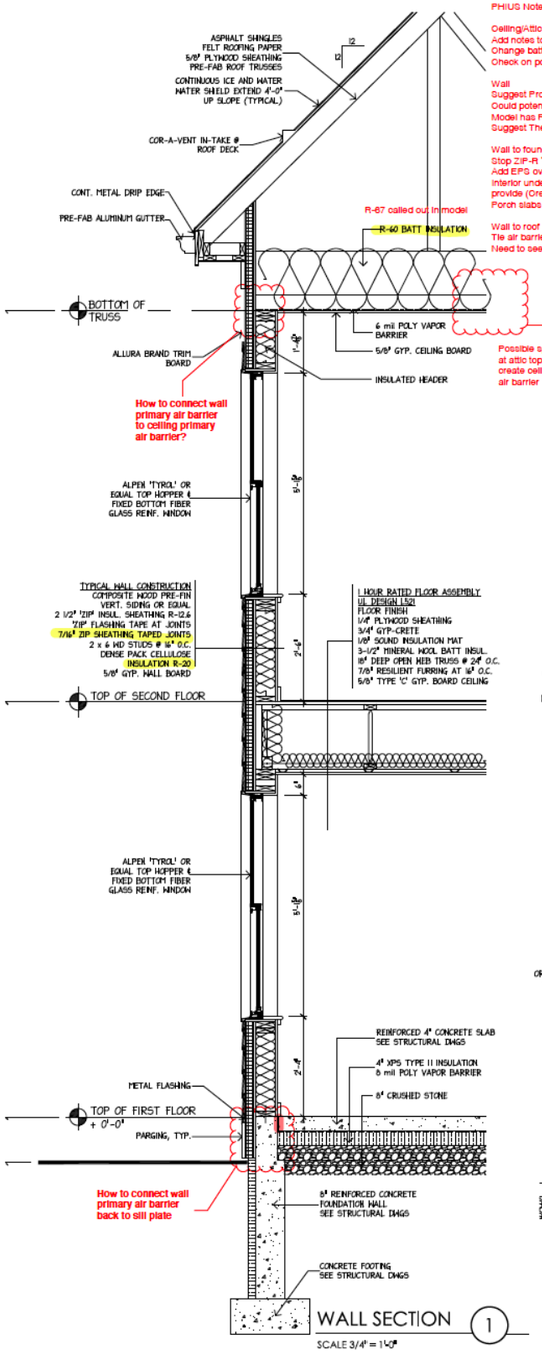
PHIUS Notes:

Ceiling/Attic
Add notes to spray foam flash layer to air seal above ceiling plan or similar
Change batts to cellulose and correct R-value
Check on poly at ceiling assembly.

Wall
Suggest Prosoco seams of ZIP rather than tape, flash windows with prosoco – At exterior layer
Could potentially downgrade ZIP to osb at layer
Model has R-23 batts in 2x6 cavity
Suggest Thermal buck at windows for connections. https://thermalbuck.com/

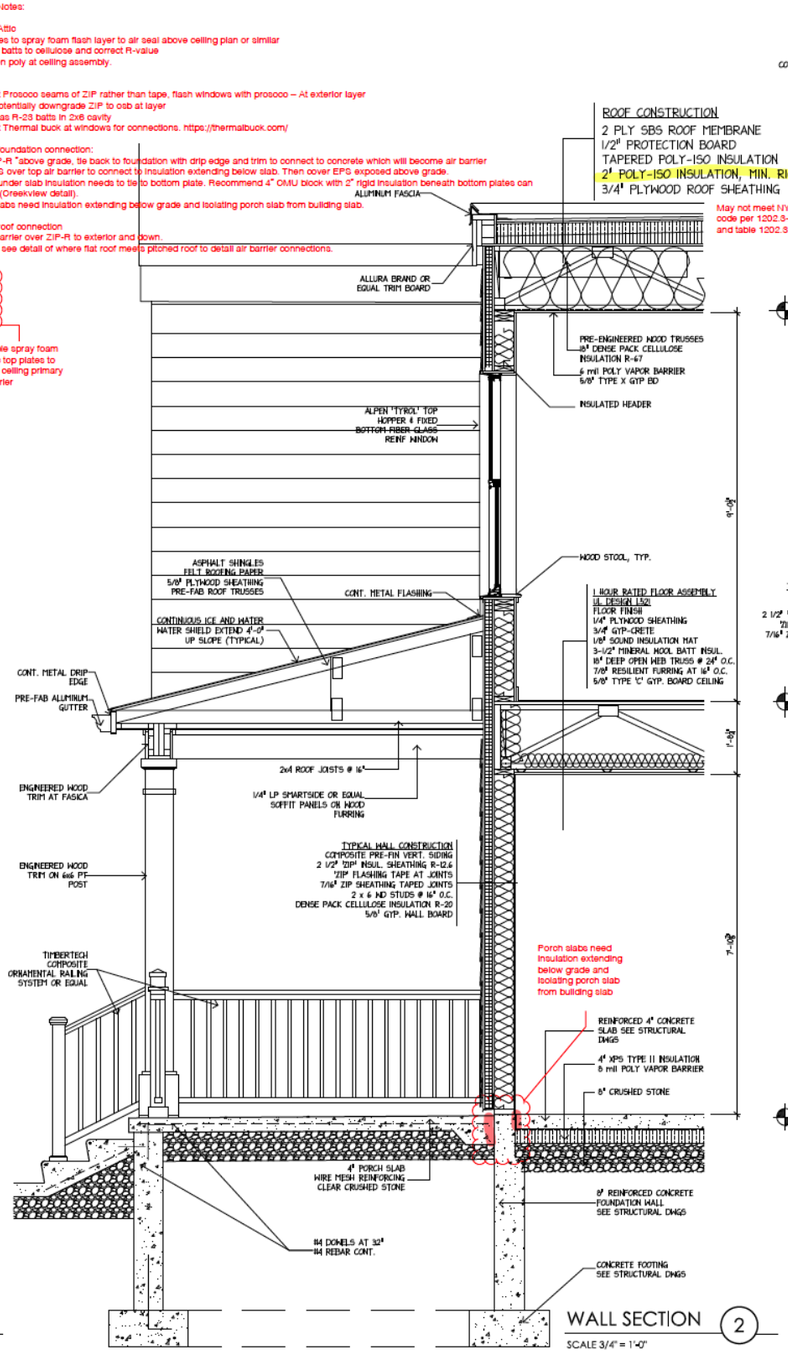
Wall to foundation connection:
Stop ZIP-R "above grade, tie back to foundation with drip edge and trim to connect to concrete which will become air barrier
Add EPS over top air barrier to connect to insulation extending below slab. Then cover EPS exposed above grade.
Interior under slab insulation needs to tie to bottom plate. Recommend 4" CMU block with 2" rigid insulation beneath bottom plates can provide (Oreekview detail).
Porch slabs need insulation extending below grade and isolating porch slab from building slab.

Wall to roof connection
Tie air barrier over ZIP-R to exterior and down.
Need to see detail of where flat roof meets pitched roof to detail air barrier connections.

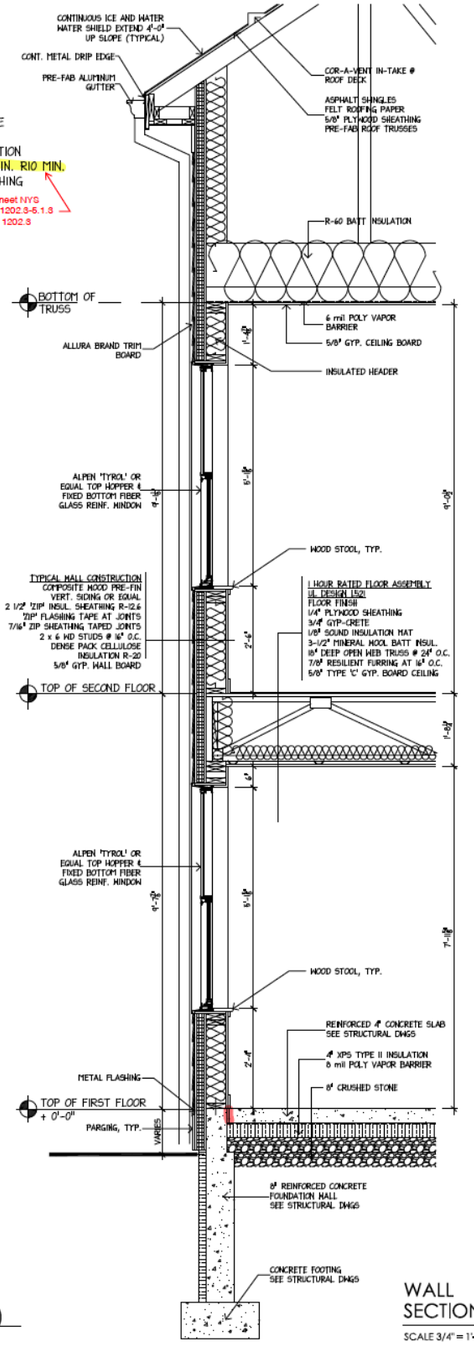


WALL SECTION 1
SCALE 3/4" = 1'-0"

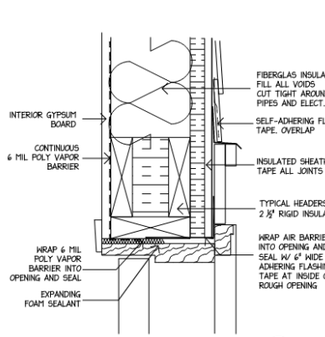
ROOF CONSTRUCTION
2 PLY SBS ROOF MEMBRANE
1/2" PROTECTION BOARD
TAPERED POLY-ISO INSULATION
2" POLY-ISO INSULATION, MIN. R10 MIN.
3/4" PLYWOOD ROOF SHEATHING
May not meet NYS code per 1202.3-5.1.3 and table 1202.3



WALL SECTION 2
SCALE 3/4" = 1'-0"

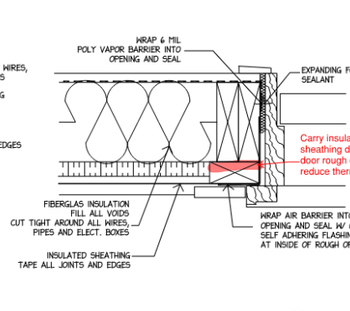


WALL SECTION 3
SCALE 3/4" = 1'-0"



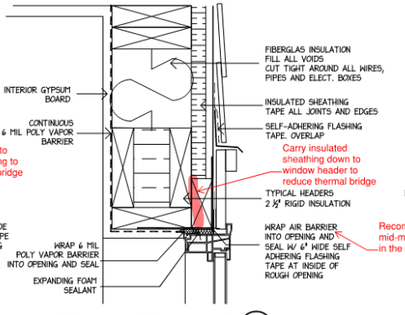
TYPICAL DOOR HEAD 4

SCALE 3" = 1'-0"



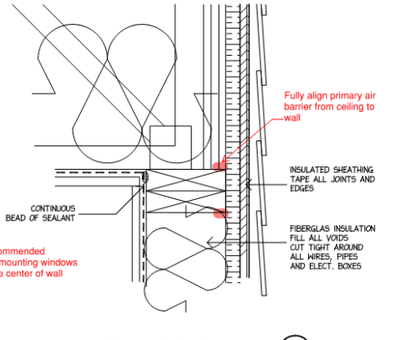
TYPICAL DOOR JAMB 3

SCALE 3" = 1'-0"



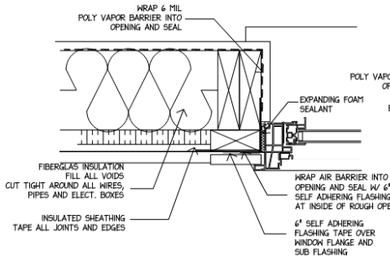
TYPICAL WINDOW HEAD 1

SCALE 3" = 1'-0"



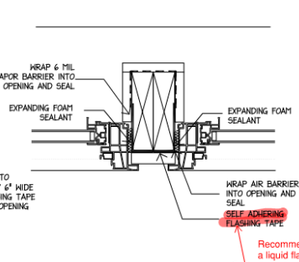
TYPICAL ROOF/ WALL 5

SCALE 3" = 1'-0"



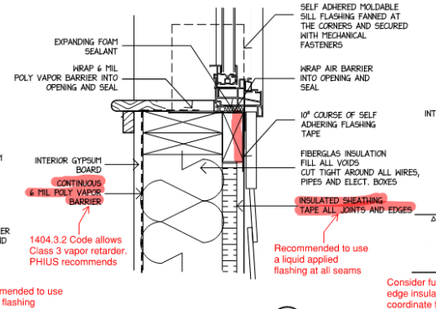
WINDOW JAMB 6

SCALE 3" = 1'-0"



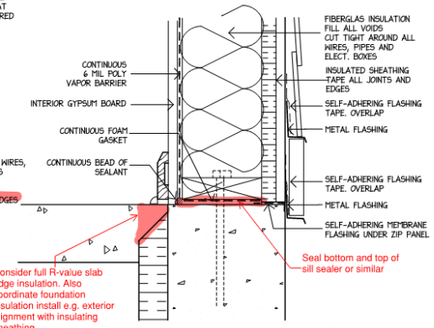
WINDOW MULLION 5

SCALE 3" = 1'-0"



TYPICAL WINDOW SILL 2

SCALE 3" = 1'-0"



TYPICAL FOUNDATION WALL 6

SCALE 3" = 1'-0"

Building shell air tightness requirement: 50 pa q1 0.060 CFM50/ft2

NOTES

DETAILS SHOWN ARE SCHEMATIC ONLY AND ARE INTENDED TO SHOW LOCATION, AND EXTENT OF AIR BARRIERS, VAPOR BARRIERS AND OTHER AIR SEALING MEASURES. REFER TO ARCHITECTURAL DRAWINGS FOR CONSTRUCTION DETAILS

MULTI-FAMILY DWELLINGS UNITS ARE REQUIRED TO BE TESTED AT A PRESSURE DIFFERENCE OF 50 PASCALS WITH RESPECT TO THE OUTDOORS AND HAVE ENVELOPE AIR LEAKAGE WHICH DOES NOT EXCEED 0.30 CFM50/SQAURE FOOT.

FULLY ALIGNED AIR BARRIERS

A COMPLETE AIR BARRIER SHALL BE PROVIDED THAT IS FULLY ALIGNED WITH THE INSULATION AS FOLLOWS:
AT INTERIOR SURFACE OF CEILINGS,
AT EXTERIOR SURFACE AND INTERIOR SURFACE OF WALLS

REDUCED TERMAL BRIDGING

ADVANCED FRAMING TECHNIQUES INCLUDE THE ITEMS BELOW:

ALL CORNERS INSULATED ≥ R-5 TO EDGE
ALL HEADERS ABOVE WINDOWS & DOORS INSULATED ≥ R-5 FOR 2X6 FRAMING
FRAMING LIMITED AT ALL WINDOWS & DOORS TO ONE PAIR OF KING STUDS, PLUS ONE PAIR OF JACK STUDS PER WINDOW OPENING TO SUPPORT THE HEADER AND SILL.
ALL INTERIOR / EXTERIOR WALL INTERSECTIONS INSULATED TO THE SAME R-VALUE AS THE REST OF THE EXTERIOR WALL.

AIR SEALING

ALL PENETRATIONS IN THE EXTERIOR WALLS AND ROOF SHALL BE FULLY SEALED WITH SOLID BLOCKING OR FLASHING AND GAPS ARE TO BE SEALED WITH CAULK OR FOAM, INCLUDING:
- DUCTS
- PLUMBING AND OTHER PIPING
- ELECTRICAL WIRING
- BATHROOM AND KITCHEN EXHAUST FANS

CRACKS IN THE BUILDING ENVELOPE SHALL BE FULLY SEALED WITH SPRAY APPLIED WATER BASED ELASTOMERIC SEALANT (ECOSEAL BY KNAUF INSULATION, ENERGYCOMPLETE BY OWENS CORNING):
- AT SILL PLATES TO THE FOUNDATION.
- AT TOP OF WALL CONTINUOUS TOP PLATES
- AT ROUGH OPENING AROUND ALL DOORS AND WINDOWS

IN ADDITION:
- FOAM GASKETS ARE TO BE PLACED BENEATH WALL SILL PLATES
- DRYWALL IS TO BE SEALED TO TOP PLATE AT ATTIC / WALL INTERFACES

ALL WALL PENETRATIONS, INCLUDING MECHANICAL, FIRE SUPPRESSION, TRASH CHUTES, ETC. MUST BE SEALED TO PREVENT AIR FLOW INTO AND THROUGH THE BUILDING'S VERTICAL CHASES.

ABOVE GRADE SILL PLATES MUST BE SEALED TO FOUNDATION OR SUBFLOOR ON ALL FLOORS

DUCTS, FLUES, SHAFTS, PLUMBING, PIPING, WIRING, EXHAUST FANS, & OTHER PENETRATIONS TO UNCONDITIONED SPACE SEALED WITH BLOCKING/FLASHING AS NEEDED.

CONTINUOUS TOP PLATES OR BLOCKING AT TOP OF WALLS ADJOINING UNCONDITIONED SPACE, AND SEALED

DRYWALL SEALED TO TOP PLATE AT ALL UNCONDITIONED ATTIC/WALL INTERFACES USING CAULK, FOAM, DRYWALL ADHESIVE, OR EQUIVALENT. APPLY SEALANT DIRECTLY BETWEEN THE DRYWALL AND TOP PLATE, OR TO THE SEAM BETWEEN THE TWO FROM THE ATTIC ABOVE.

ALL DEMISING WALLS BETWEEN UNITS AIR SEALED AS EXTERIOR WALLS.

ALL PENETRATIONS INTO DEMISING WALLS SEALED.

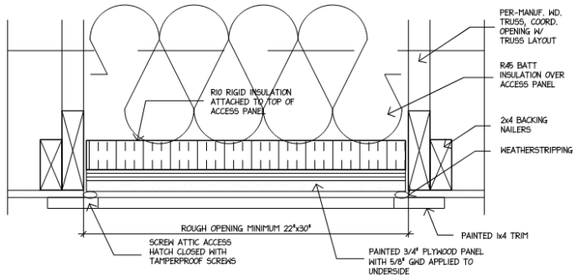
WIRING AND ANY HOLES INTO ANY OUTLET BOX ON DEMISING WALLS AND EXTERIOR WALLS SEALED WITH CAULK OR FOAM AND OUTLET BOX CAULKED TO DRYWALL.

BLOCKING EXTENDING INTO INTERSTITIAL SPACE ABOVE DEMISING WALLS. AIR SEALED TO FORM A CONTINUOUS PLANE AND ANY PENETRATIONS SEALED.

DOORS TO HALLWAYS AND UNCONDITIONED SPACE MADE AIR TIGHT WITH WEATHER STRIPPING.

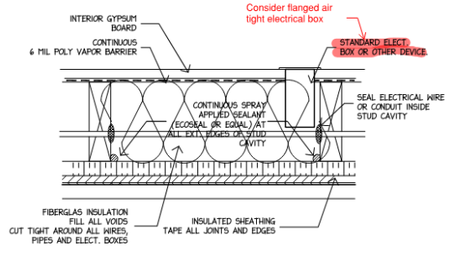
ALL WALL PENETRATIONS TO TRASH CHUTES ARE TO BE SEALED TO PREVENT AIR FLOW INTO OR THROUGH THE VERTICAL SHAFT

AIR SEALING STRATEGIES TO BE REVIEWED WITH THE HERS RATER TO MEET ALL INSPECTION REQUIREMENTS OF THE ENERGY STAR PROGRAM AND BLOWER DOOR TESTING THRESHOLDS OF EACH UNIT.
IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO PROVIDE AIR TIGHT UNITS THAT MEET THE COMPARTMENTALIZATION TESTING OF THE ENERGY STAR AND NYSERDA PROGRAMS.



ATTIC ACCESS DOOR DETAIL 6

SCALE 1 1/2" = 1'-0"

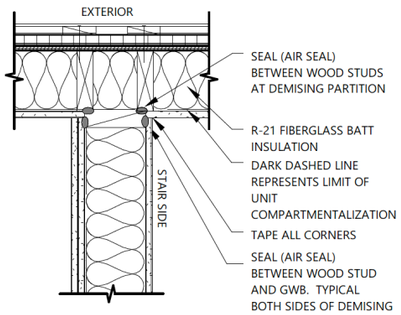


STUD CAVITY CONTAINING ELECT. DEVICE 10

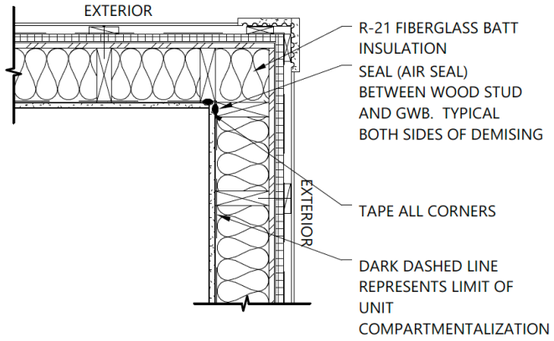
SCALE 3" = 1'-0"

Value in a Different Perspective

- Energy Star / Code Compliance
  - PHIUS Verification - IR Imaging



1 EXTERIOR WALL MEETS STAIR WALL
1" = 1'-0"

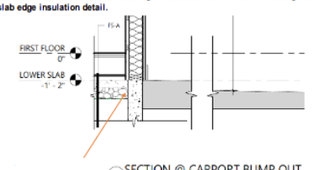


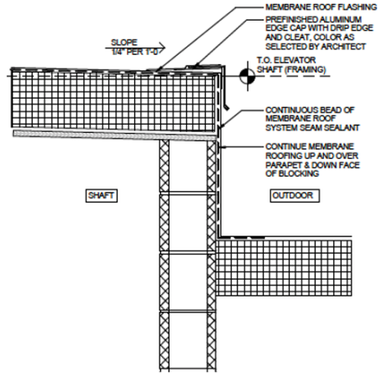
2 EXTERIOR WALL CORNER
1" = 1'-0"

Item	Equipment / Checklist Item	Drawing/Spec*	Responsible Party	Program Requirement	SCI Comment	Arch/MEP Response
Energy Star Rater Field Checklist						
10	Item 3.4 Wall Thermal Bridging: Advanced Framing	A5.03, S6.03	Architect	*Without the use of exterior rigid insulation, SIPs, ICFs, or Double-Wall Framing. At above-grade walls separating conditioned from unconditioned space, advanced framing (3.4.3) must be utilized, including all items below:* ***3.4.3a:*** *Corners insulated to >= R-6 to edge* ***3.4.3b:*** *Headers above windows & doors insulated ≥ R-3 for 2x4 framing or equivalent cavity width, and ≥ R-5 for all other assemblies (e.g., with 2x6 framing)* ***3.4.3c:*** Framing limited at all windows & doors to one pair of king studs, plus one pair of jack studs per window opening to support the header and sill **3.4.3d:** Interior / exterior wall intersections insulated to same R-value as rest of exterior wall, **3.4.3e** Minimum stud spacing of 16 in. o.c. for 2x4 framing in all Climate Zones and, in CZ 6-8, 24 in. o.c. for 2x6 framing.	Ensure all advanced framing techniques are indicated in both Architecturals and Structural Plans. 3.4.3a: Corner needs to be framed open (California Corner) to ensure insulators can insulate the corner. Click comment for further details. 3.4.3b: Provide additional details for insulated headers 3.4.3c: Typical Wood Header Detail on S6.03 indicates framing may will not meet requirements at all exterior openings 3.4.3d: Detail 9 on A5.03 does not indicate compliance with this requirement. 3.4.3e: Requirement met	

Design Considerations

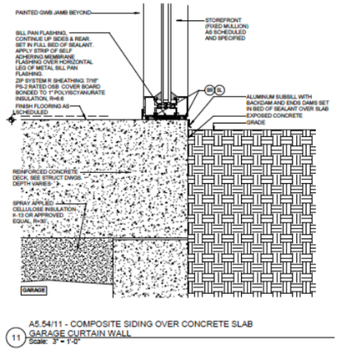
- Thermal Bridging
  - Energy Star Homes & MFNCP / Code Compliance
  - PHIUS - IR Imaging

			Reviewer	Isaiah Grigos / Greg Downing		
			Programs	Energy Star Homes V3.1 & PHIUS+ 2018		
			Plans/Specs Reviewed	2/5/2021 - 95% CD		
	*Note: Where specific sheet numbers are referenced below, comments may also pertain to other sheets in the set or other buildings where similar conditions exist.				Drawing Set Date: 2/5/2021	
Item	Equipment / Checklist Item	Drawing/Spec*	Responsible Party	Program Requirement	SCI Comment	Arch/MEP Response
Energy Star Version 3.1 Items						
Rater Field Checklist						
4	Item 1.3: Insulation Quality	Specifications	Architect	*All insulation achieves Grade I install, or Grade II is permitted for assemblies that contain a layer of continuous air impermeable insulation >=R-5 in CZ 5-8. Grade II Batts are permitted to be used in floors if they fill the full width and depth of the floor cavity, even when compression occurs due to excess insulation.*	**Recommend adding requirement language to specifications. All exterior assemblies will need to meet Grade I installations.**	
8	Item 3.2: Thermal Bridging at Slabs	S4.02 | A6.02 | A4.06	Architect	*For slabs on grade in CZ 4-8, 100% of slab edge insulated to ≥ R-5 at the depth specified by the 2009 IECC and aligned with the thermal boundary of the walls. (See Footnotes 15,16)*	**1) Indicate R value for all slab edge locations. Recommend doing this in a detail on A6.02. Insulation with R values should be indicated in both architecturals and structural drawings. Cut below from A4.06 is missing the slab edge insulation detail.**  2 SECTION @ CARPORT BUMP OUT 1/2" = 1'-0"	



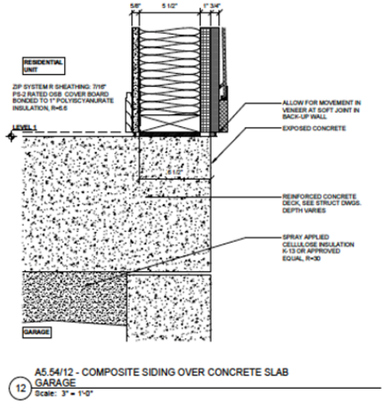
30 ELEVATOR - SECTION - AT ROOF
Scale: 1 1/2" = 1'-0"

A6.34 – Rigid insulation should continue up elevator shaft wall and link with insulation above elevator shaft



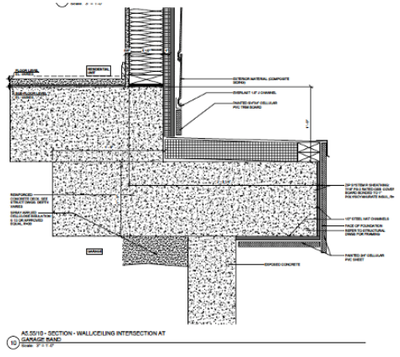
11 A5.54/11 - COMPOSITE SIDING OVER CONCRETE SLAB GARAGE CURTAIN WALL
Scale: 3" = 1'-0"

A5.54 – Elevated slab over garage needs to be isolated and insulated. See Energy Star requirement below.



12 A5.54/12 - COMPOSITE SIDING OVER CONCRETE SLAB GARAGE
Scale: 3" = 1'-0"

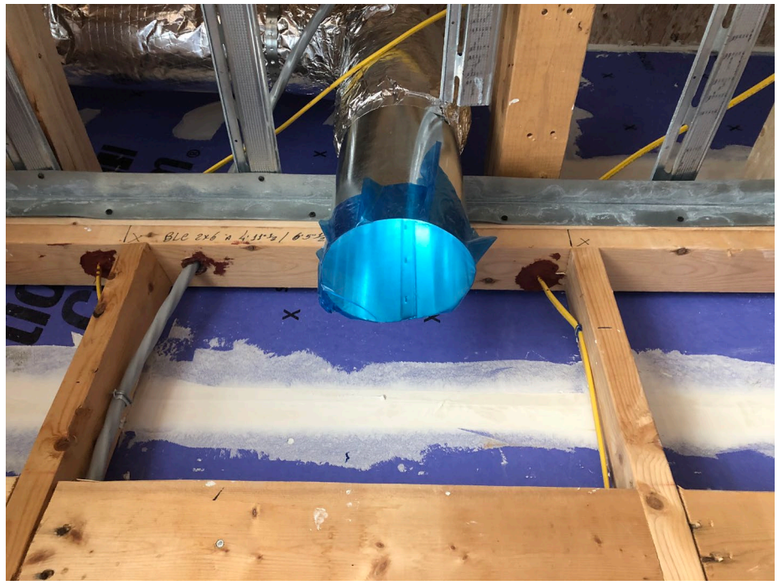
A5.54 – Elevated slab over garage needs to be isolated and insulated. See Energy Star requirement below.

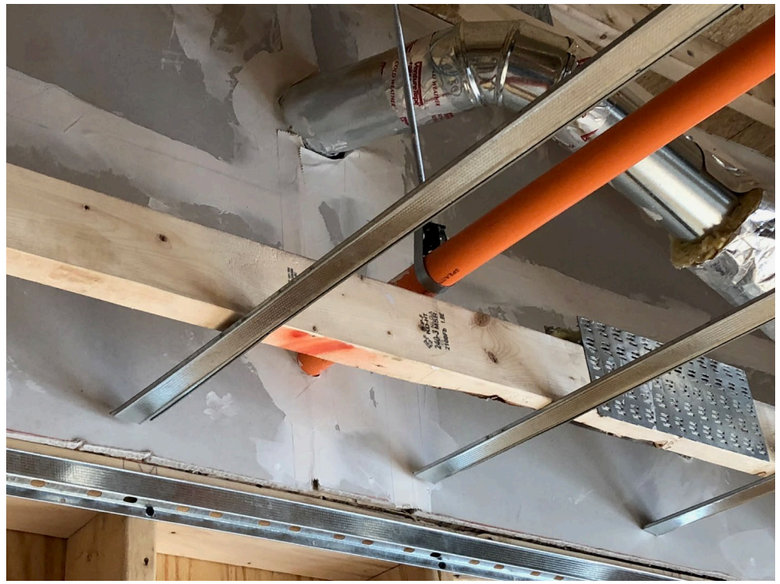


A5.55 – Energy Star MFNC elevated slab requirements require isolating the slab and reducing thermal bridging through support columns. See full requirements below

Design Considerations

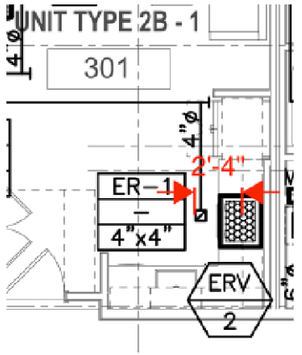
- Compartmentalization Testing
  - 0.30 CFM/SF Shell in each unit
  - NYS ECCC & PHIUS requirement
  - Important to include air sealing details at demising walls and identify who is responsible





Design Considerations

- Additional HVAC Requirements
  - ERV requirements when exhausting from kitchen
  - Room pressure testing with ERV operational.
  - Measure ERV supply and exhaust rates vs design values
    - Ability to balance system
    - ERV duct leakage
    - Watt/ CFM measurement

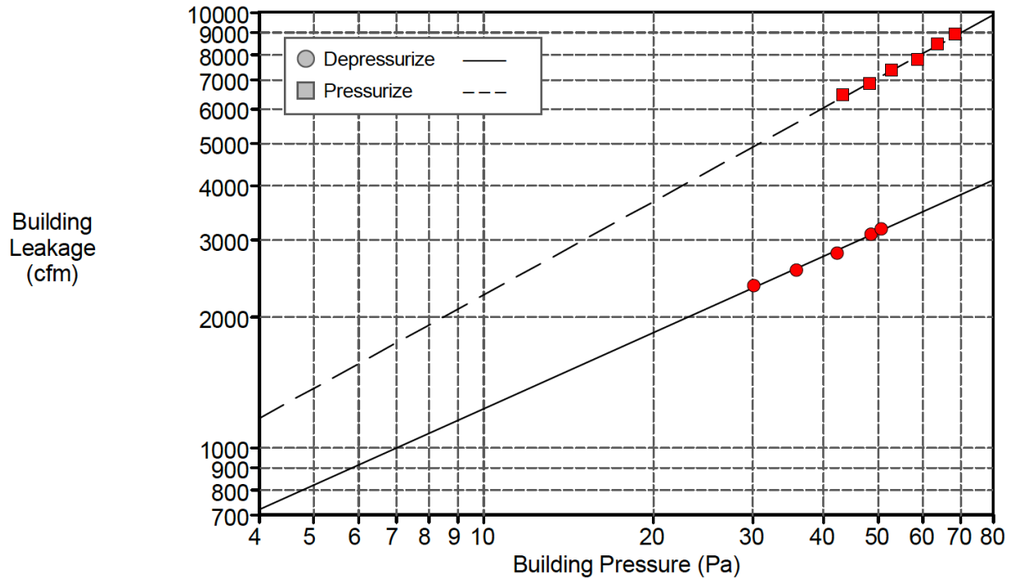
Item	Equipment / Checklist Item	Drawing/Spec*	Responsible Party	Program Requirement	SCI Comment	Arch/MEP Response
PHIUS MF QA Workbook						
15	Item 1.12	M1.02, M1.03	Mechanical	If kitchen exhaust connected to ERV/HRV, register is min. 6' from cooktop, MERV 3 or washable mesh filter for trapping grease, and recirc hood over range	**If kitchen exhaust is linked to ERV, exhaust register needs to be ≥ 6' from the cooktop. Majority of kitchen exhausts are indicated within this 6' restriction.** 	

Plan Accordingly

- Optional Mid-Point Blower Door Test
  - Sequencing for this test is challenging
  - Test results are critical to catch and correct deficiencies in primary air barrier
- Final Whole Building Blower Door Test
  - Whole building testing – 0.06 CFM50/sf of buildings gross envelope area performed in both pressurization and depressurization.

Test Results at 75 Pascals:	Depressurization	Pressurization	Average
cfm (Airflow)	3972 (+/- 6.0 %)	9440 (+/- 3.2 %)	6706 (+/- 2.9 %)
ACH75	0.82	1.95	1.39
cfm/ft² (Floor Area)	0.1592	0.3782	0.2687
cfm/ft² (Surface Area)	0.1393	0.3310	0.2351
Leakage Areas:			
Canadian EqLA @ 10 Pa (in²)	361.4 (+/- 13.2 %)	660.3 (+/- 15.9 %)	510.9 (+/- 11.3 %)
in²/ft² Surface Area	0.0127	0.0232	0.0179
LBL ELA @ 4 Pa (in²)	204.9 (+/- 21.7 %)	332.1 (+/- 24.4 %)	268.5 (+/- 17.2 %)
in²/ft² Surface Area	0.0072	0.0116	0.0094
Building Leakage Curve:			
Flow Coefficient (C)	322.3 (+/- 34.6 %)	436.0 (+/- 37.2 %)	379.1 (+/- 25.9 %)
Exponent (n)	0.582 (+/- 0.093)	0.712 (+/- 0.093)	0.647 (+/- 0.066)
Correlation Coefficient	0.99623	0.99564	
Test Standard:	E779-10		
Test Mode:	Depressurization and Pressurization		

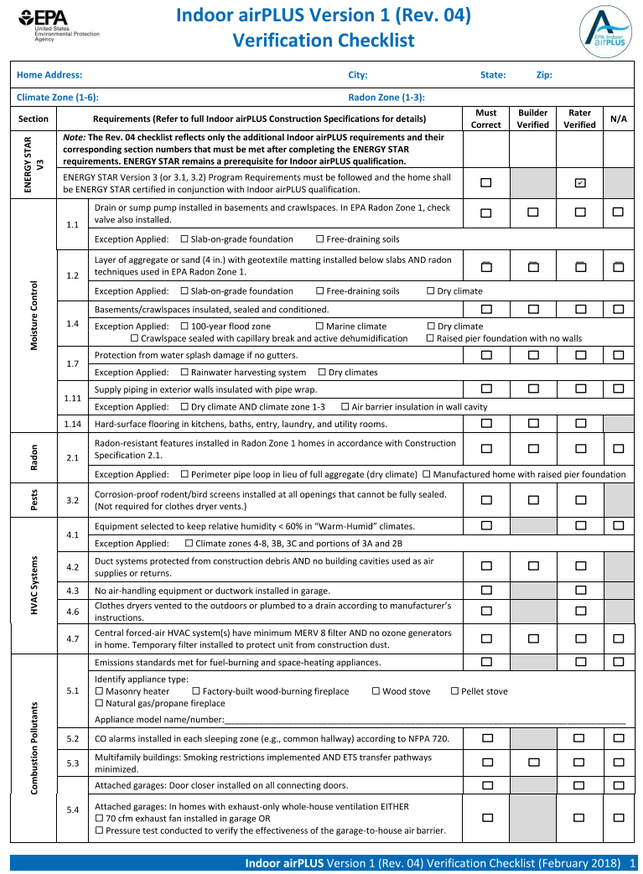
Image 2 - Blower Door Double Shroud Setup



Additional Program Requirements

- DOE ZERH – Hot Water Distribution Testing
- EPA Indoor airPlus
  - Radon resistant requirements
  - Low VOC products
  - Ventilation after Material Installation

Item	Equipment / Checklist Item	Drawing/Spec*	Responsible Party	Program Requirement	SCI Comment	Arch/MEP Response
EPA Indoor Air Plus						
1	Moisture Control (1.2)		Architect	Layer of aggregate or sand (4 in.) with geotextile matting installed below slabs AND radon techniques used in EPA Radon Zone 1.	Ensure project is meeting Radon resistant requirements.	
2	HVAC Systems (4.2)		Architect	Duct systems protected from construction debris AND no building cavities used as air supplies or returns	Note that duct systems need to be sealed off during construction to prevent debris from entering	
3	Item 6.1 - 6.3: Materials		Architect	6.1: All composite wood products certified low-emission. See spec. 6.2: Interior paints and finishes certified low-emission. See spec. 6.3: Carpet, carpet adhesives, and carpet cushion certified low-emission. See spec.	SCI did not see a finish schedule in plans. Ensure Low-emission criteria is met for all product selections.	
4	Item 7.2 - Final		Architect	Home ventilated before occupancy.	This requirement should be indicated in Specifications and a plan should be implemented with the property management group.	
Net Zero Energy Ready Home						
	Net Zero Energy Ready Home Checklist		Electrical	Install a 1" metal conduit for the DC wire run from the designated array location to the designated inverter location (cap and label both ends). (RERHPV Guide		
	Net Zero Energy Ready Home Checklist		Electrical	Install a 1" metal conduit from designated inverter location to electrical service panel (cap and label both ends). (RERHPV Guid		
	Net Zero Energy Ready Home Checklist		Electrical	Install and label a 4' x 4' plywood panel area for mounting an inverter and balance of system components. (RERHPV Guide 3.1) Alternative: Blocking is permitted to be used as an alternative to the 4' x 4' panel. The area designated for the future panel to mount PV components shall be clearly noted in the system documentation		
	Net Zero Energy Ready Home Checklist		Electrical	Install a 70-amp dual pole circuit breaker in the electrical service panel for use by the PV system (label the service panel) (RERHPV Guide 3.4) Alternative: Provide a labeled slot for a double-pole breaker in the electrical		



Indoor airPLUS Version 1 (Rev. 04) Verification Checklist

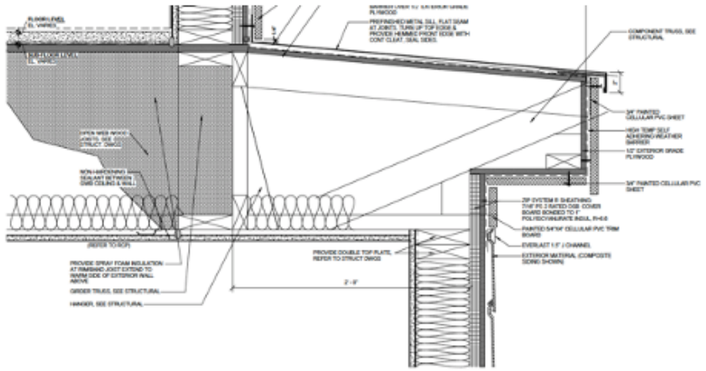
Home Address: City: State: Zip:

Climate Zone (1-6): Radon Zone (1-3):

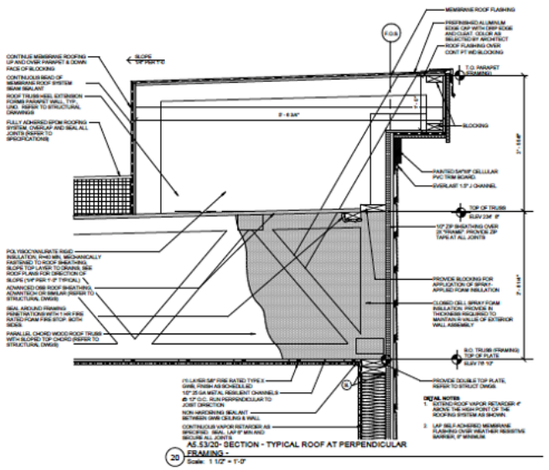
Section		Requirements (Refer to full Indoor airPLUS Construction Specifications for details)	Must Correct	Builder Verified	Rater Verified	N/A
ENERGY STAR V3		***Note:* The Rev. 04 checklist reflects only the additional Indoor airPLUS requirements and their corresponding section numbers that must be met after completing the ENERGY STAR requirements. ENERGY STAR remains a prerequisite for Indoor airPLUS qualification.**				
		ENERGY STAR Version 3 (or 3.1, 3.2) Program Requirements must be followed and the home shall be ENERGY STAR certified in conjunction with Indoor airPLUS qualification.	☐		☑	
Moisture Control	1.1	Drain or sump pump installed in basements and crawlspaces. In EPA Radon Zone 1, check valve also installed.	☐	☐	☐	☐
		Exception Applied: ☐ Slab-on-grade foundation ☐ Free-draining soils				
	1.2	Layer of aggregate or sand (4 in.) with geotextile matting installed below slabs AND radon techniques used in EPA Radon Zone 1.	☐	☐	☐	☐
		Exception Applied: ☐ Slab-on-grade foundation ☐ Free-draining soils ☐ Dry climate				
	1.4	Basements/crawlspaces insulated, sealed and conditioned.	☐	☐	☐	☐
		Exception Applied: ☐ 100-year flood zone ☐ Marine climate ☐ Dry climate ☐ Crawlspace sealed with capillary break and active dehumidification ☐ Raised pier foundation with no walls				
	1.7	Protection from water splash damage if no gutters.	☐	☐	☐	☐
		Exception Applied: ☐ Rainwater harvesting system ☐ Dry climates				
	1.11	Supply piping in exterior walls insulated with pipe wrap.	☐	☐	☐	☐
		Exception Applied: ☐ Dry climate AND climate zone 1-3 ☐ Air barrier insulation in wall cavity				
	1.14	Hard-surface flooring in kitchens, baths, entry, laundry, and utility rooms.	☐	☐	☐	
Radon	2.1	Radon-resistant features installed in Radon Zone 1 homes in accordance with Construction Specification 2.1.	☐	☐	☐	☐
		Exception Applied: ☐ Perimeter pipe loop in lieu of full aggregate (dry climate) ☐ Manufactured home with raised pier foundation				
Pests	3.2	Corrosion-proof rodent/bird screens installed at all openings that cannot be fully sealed. (Not required for clothes dryer vents.)	☐	☐	☐	
HVAC Systems	4.1	Equipment selected to keep relative humidity < 60% in "Warm-Humid" climates.	☐		☐	☐
		Exception Applied: ☐ Climate zones 4-8, 3B, 3C and portions of 3A and 2B				
	4.2	Duct systems protected from construction debris AND no building cavities used as air supplies or returns.	☐	☐	☐	
	4.3	No air-handling equipment or ductwork installed in garage.	☐		☐	
	4.6	Clothes dryers vented to the outdoors or plumbed to a drain according to manufacturer's instructions.	☐		☐	
	4.7	Central forced-air HVAC system(s) have minimum MERV 8 filter AND no ozone generators in home. Temporary filter installed to protect unit from construction dust.	☐	☐	☐	☐
Combustion Pollutants	5.1	Emissions standards met for fuel-burning and space-heating appliances.	☐		☐	☐
		Identify appliance type: ☐ Masonry heater ☐ Factory-built wood-burning fireplace ☐ Wood stove ☐ Pellet stove ☐ Natural gas/propane fireplace Appliance model name/number:_____				
	5.2	CO alarms installed in each sleeping zone (e.g., common hallway) according to NFPA 720.	☐		☐	☐
	5.3	Multifamily buildings: Smoking restrictions implemented AND ETS transfer pathways minimized.	☐	☐	☐	☐
		Attached garages: Door closer installed on all connecting doors.	☐		☐	☐
	5.4	Attached garages: In homes with exhaust-only whole-house ventilation EITHER ☐ 70 cfm exhaust fan installed in garage OR ☐ Pressure test conducted to verify the effectiveness of the garage-to-house air barrier.	☐		☐	☐

Building Durability

- In addition to Program Checklist review, another set of eyes may help catch issues that potentially compromise building durability



A5.57 – If unvented attic assembly, spray foam should link the two exterior walls together via underside of roof deck

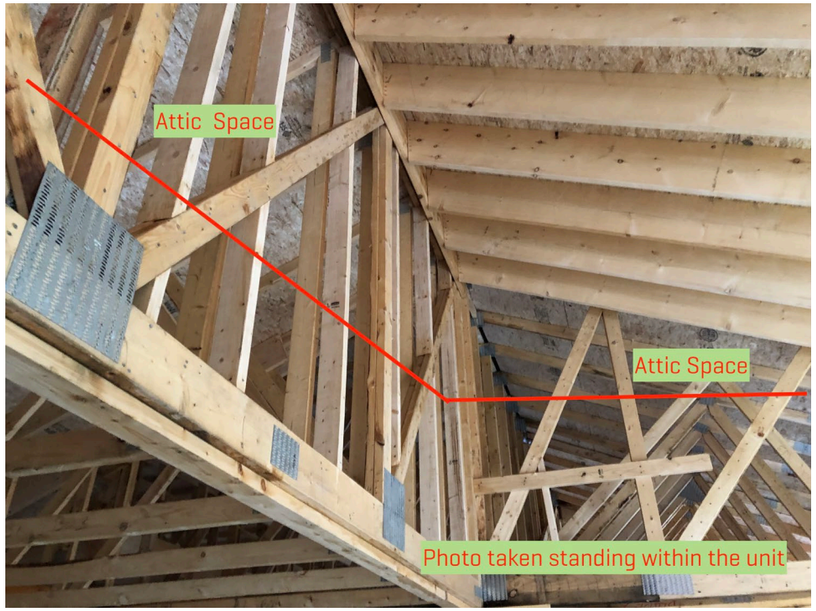


A5.53 – Spray foam should link with the rigid insulation above the roof deck

The Field Issues Persist..

- Involvement in design improves awareness to compliance items in the field and builds rapport with construction personnel

- Early on-site meetings with the GC and trades will allow for discussion of the inspection requirements and troubleshoot potential issues from their perspective



PHIUS+ Certification Process

Schematic Design: Initial Layout and Systems

Pre-Certification: Approved Modeling and CD's

Construction Inspections: Insulation & Air Sealing Checks

Final Testing: Air Tightness & Commissioning

Certification: Final Certifications

Case Study – CreekView Apartments Phase I

Features

- 96 Units in 12 Buildings
- 8-Plex Design, mix of 1, 2, and 3 bedroom units
- Programs:
    - PHIUS+ 2015
    - NYSERDA Low Rise
    - Energy Star Homes V3.1
    - DOE Net Zero Energy Ready
    - EPA Indoor AirPlus

Insulation Levels

Wall Insulation

- R-37 Wall
  - 2x6 Wood Studs - R-21 Batt
  - OSB Sheathing
  - Fluid Applied Air Barrier
  - 3.5” Exterior Panel R-19 (Polyiso + Osb)
  - Tyvek weather barrier
  - Vinyl Siding

Insulation Levels

No Thermal Bridging

- Continuous insulation at walls
- Porch point connections
- Storage room held away
- Foundation walls held away

Insulation Levels

Windows/Doors

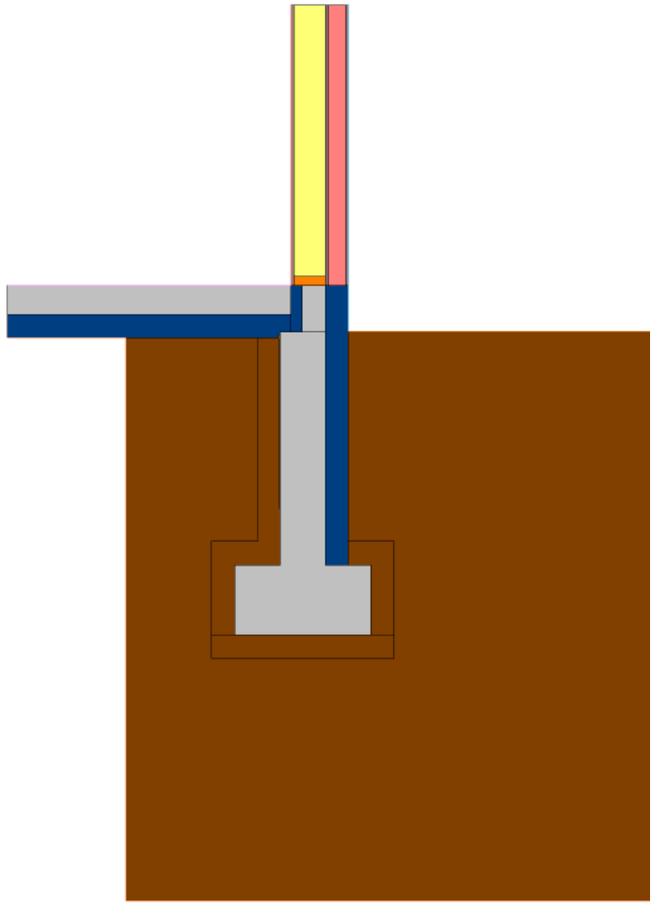
- Triple pane insulated
- Casements/Fixed for air tightness
- ADA sills vs. air tightness
- Fall protection?

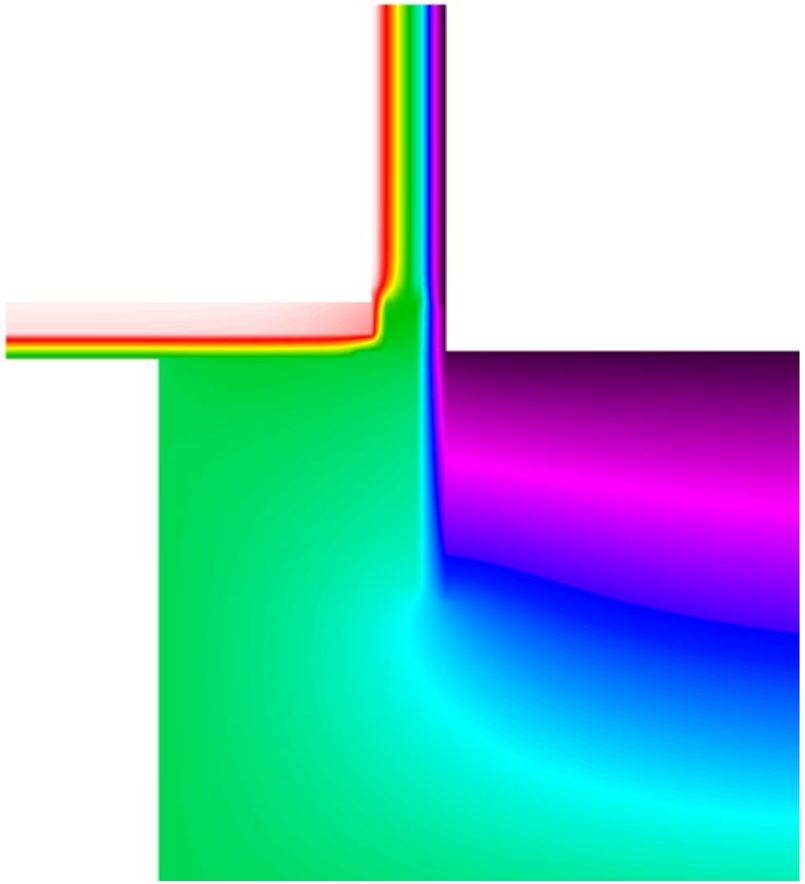
Insulation Levels

Sub-Slab Insulation

- R-15 Underslab Insulation
  - 3” EPS Foam
  - Vapor Retarder
  - Concrete Slab
- Slab Edge Detailing
  - 2” vertical slab edge
  - 4” exterior foundation wall

Foundation Insulation Inspection





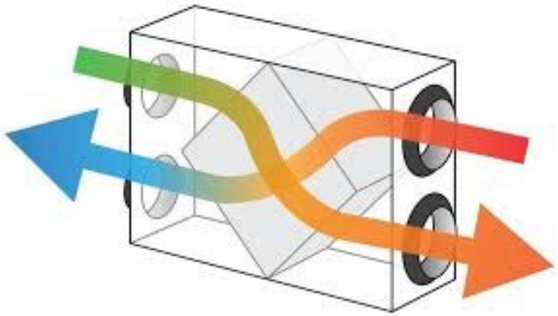
Attic Air Sealing

Ceiling Insulation

- R-60 to R-80 Wall
  - OSB Sheathing as primary air barrier
  - Taped seams
  - Drywalled ceiling

Mechanical Systems

Ventilation



- Panasonic FV-10VEC1
- Continuous Exhaust
  - Bathroom: 20 CFM
  - Kitchen: 25 CFM
- Supply register to each room
- Range hood recirculating

Mechanical Systems Installation

Install air source heat pumps off the ground adequate for snow not to interfere with operation

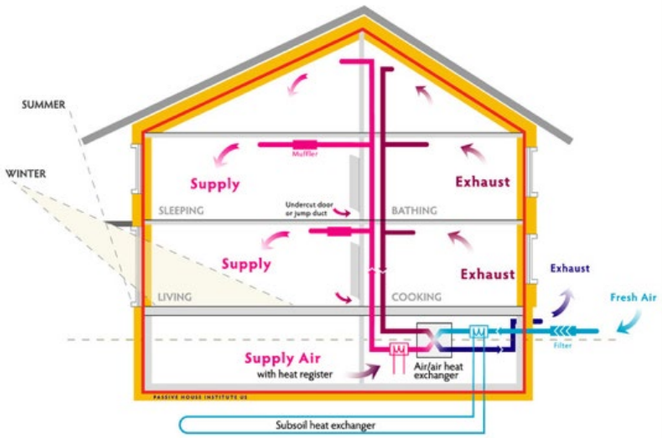
The Value of Verification

Identifying major constructability items that may have been overlooked

Preparing for and performing the whole building air tightness testing/Compartmentalization

Important to catch design/product issues early, ideally at air sealing or open wall inspection

PHIUS verification overlaps with other energy green program requirements



PHIUS+ VERIFIER

Foundation Insulation Inspection

Install Coordination

Primary Air Barrier Failure

Fluid Applied Air Barrier

Concept

Reality

Result

Preliminary Testing

Interior Spray Foam

Test 1: Initial Pre-Test
970 CFM50

Test 2: Spray Foam Interior
862 CFM50

Target: Continuous Air Barrier
706 CFM50

Continuous Ceiling Air Barrier

Concept

Reality

Result

Quality of Install

Connections

Building Components

Material Selection

Reality

Material Compatibility

Air Sealing Detail Verification

PHIUS+ Certification Process

Schematic Design: Initial Layout and Systems

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Air Tightness Testing

Air Tightness

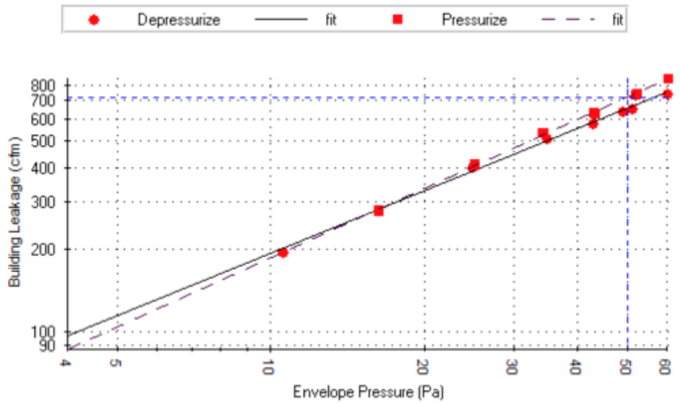
- Continuous air barrier across building
- Air tight windows (casement) and doors
- Buildings meet 0.05 CFM50/sf of Shell
- Testing occurred pre-drywall and final

Air Tightness Testing

Results:

- Target: 0.05 CFM50/sf of Shell

UNIT	ENVELOPE AREA	TARGET BLOWER DOOR TARGET (@50Pa)
3 Bedroom	17,192	860
2 Bedroom	14,113	706
1 Bedroom	11,481	574



Label	Base?	start	end	nobs	Nominal Avg Pressure	Nominal Total Flow
	True	20	137	118	-1.31	0
	False	1414	1432	19	-60.9	811.7
	False	1507	1526	20	-52.09	713
	False	1595	1611	17	-49.98	696.3
	False	1620	1639	20	-43.81	631.4
	False	1718	1736	19	-35.88	556.5
	False	1818	1837	20	-26.04	439.4
	False	1926	1945	20	-11.71	213.9
	True	2507	2623	117	-.97	0

Copy Data Table to Clipboard

Reporting Pressure (Pa) 50

Test to View average

Average of Press and Depress

Airflow at 50 Pascals

690 cfm +/- 1.6 %

Range: 679 to 701

0.049 CFM @50/sq ft (0.023 to 0.024)

Leakage Areas

EqLA (10 Pa) = 55.9 in2 +/- 3.5 %

ELA (4 Pa) = 26.0 in2 +/- 6.0 %

Building Leakage Curve

Coef. (C) = 30.3 cfm/Pa^n +/- 10.0 %

Exponent (n) = .800 +/- 0.024

Correlation Coef. (r) = .99898

Corr Coef Squared (r^2) = .99795

View / Edit Test Details

Export to Tectite Express...

USACE Report

OK

Air Tightness Testing

Final Verification

Additional Verification

- Hot Water Distribution
- Ventilation Flow Rates
- Ventilation wattages
- Final equipment efficiencies

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Schematic Design: Initial Layout and Systems

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Certification: Final Certifications

Certification

Timeline:

- PHIUS+ Verifier submission for review
- Completed PHIUS+ Workbook
-Verification Picture
-Thermal Imaging
- Finalized additional certifications
    - NYSERDA Low Rise New Construction
    - Energy Star Homes V3.1
    - DOE Net Zero Energy Ready
    - EPA Indoor AirPlus

CreekView Apartments Ph 1

BALDWIN
a DiMarco Group company

DIMARCO GROUP

DiMarco Constructors

Glasow Architecture

EC4B engineering, p.c.

SUSTAINABLE COMFORT

Special Thanks to the Project Team!

CreekView Apartments Phase II

CreekView Apartments
Canandaigua, NY

Early Design
$1 Million Award

BALDWIN
a DiMarco Group company

DIMARCO GROUP

DiMarco Constructors 50 YEARS 1965 – 2015

Glasow Architecture

EC4B engineering, p.c.

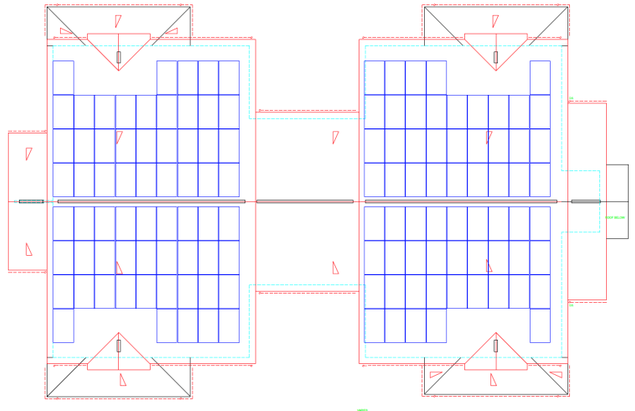
SUSTAINABLE COMFORT

How to get a PHIUS Project to Net Zero?

- Size of roof now dictates source energy, how to reduce building loads to fit in budget of roof produced solar.
- Geothermal heating/cooling/DHW central per building
- Central ERV systems to reduce construction and maintenance cost
- Solar PV – Owner paid remote net metering
  - Owner pays all utilities for the project
  - 108 Individual Electric Meters – 1 apt meter + 1 blg meter
  - Solar PV on each building tied into 1 owner meter

Integrated Process

- Feedback from all contractors for ideas welcomed
- Regular check points to reassess project goals
- Net-Zero goal dictates final loads of the building
- Solar capacity constrained by roof sizing and orientation
- Building orientations optimized
- Insulation and equipment sized to solar capacity



Questions?

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Chris Straile
chris@greenrater.com

SUSTAINABLE COMFORT