



PHIUS Certified Rater Training

Phius Certified Rater Training

Welcome!
Introductions: Your Name & Company



On-site Verification

Anthony Lisanti, CEM, CPHC

- Phius Rater Instructor
- Phius Rater, Verifier & CPHC
- Phius QA/QC Manager
- Phius Tech Committee
- RESNET QAD & Trainer
- Integral Building & Design
- Nyack & New Paltz, NY
- NY Mets Fan (long suffering – perhaps not for long)



On-site Verification

1. Understand Rater Prerequisites
2. Phius Certified Rater's Role
3. Prerequisite Programs
4. Getting Started- Project Review
5. Project QA

On-site Verification

6. Construction Inspections

7. Program Checklists

8. Documentation

9. Final Testing & Inspection

10. HVAC Balancing

11. Submitting Projects for QA & Certification

Prerequisites for Phius Certified Raters

- Attend Phius Rater training and pass exam
- Complete and return Phius Certified Rater Agreement
- Rater in good standing with RESNET
- Aligned with a RESNET QA Provider
 - In CA;
 - Rater in good standing with RESNET
 - Aligned with a RESNET QA Provider, or,
 - A California Energy Commission approved Provider
 - In AK;
 - Rater in good standing with RESNET
 - Aligned with a RESNET QA Provider, or,
 - A Certified Rater through Alaska Housing Finance Corp

Prerequisites for Phius Certified Raters cont'd

- In Canada;
 - Certified Rater in good standing with CRESNET or Natural Resources Canada
 - Attest to knowledge and understanding of all EPA and DOE Programs
- Other Countries;
 - Evaluated on a case by case basis
 - Attest to knowledge and understanding of all EPA and DOE Programs

Prerequisites for Phius Certified Raters cont'd

Required prior to taking Exam

- Rater in good standing with RESNET
- Aligned with a RESNET QA Provider
- EPA Energy Star Rater Partner
 - Energy Star v3.0 Training
 - Energy Star MFNC Training
- RESNET MF Training Modules
- EPA Indoor airPLUS Partner
- DOE ZERH Partner

Phius Standard Development Timeline/Milestones

- 2011 Phius created 3rd party QA/QC project certification based on RESNET Standards for Passive projects
- 2012 Integrated EPA E-Star, IAP and DOE ZERH into Phius Certification program
- 2015 Phius 2015 – first climate specific Passive building standard
- 2018 Phius 2018 – path to ZERO
- 2020 Phius begins to initiate ASHRAE 227P Passive Building Standard
- 2021 Phius 2021 Passive Building Standard updates

Phius Standard Development Timeline/Milestones



For 2021 there are 3 options:

- Phius Core 2021
- Phius CORE Prescriptive (Single Family only)
- Phius 2021 Source Zero

Phius CORE Prescriptive 2021

Single Family and Townhomes only

- Uses Climate zone specific criteria and Snapshot
 - Online tool used to determine design criteria
 - Cannot be Certified to Phius Source Zero
 - No WUFI Modeling required
 - Phius Certified Consultant not required (recommended)
 - Raters Can use the Prescriptive modeling sps to evaluate design
- Climate Specific Prescriptive Tables need to be met

Phius CORE Prescriptive 2021

The Phius CORE Prescriptive program is limited to single family detached residences, townhomes, and duplexes


iCFA/Bedrooms < 900 sf

No fossil fuel combustion equipment

No jetted tubs/indoor pools

No Natural Draft fireplaces

phius CORE Prescriptive 2021 Snapshot



Input or select data in orange cells

State	NEW YORK
City	WHITE PLAINS WESTCHESTER
ASHRAE Climate Zone	5A
iCFA* (ft ²)	3000
Number of Bedrooms*	4
Number of Stories	2

*per dwelling unit

1. GENERAL

1.1.2 iCFA divided by Number of Bedrooms
(Calculated Value based on Inputs)

Maximum Limit	750	ft ²
Warning: Exceeds Maximum Limit	750	ft ²

3. COMPACTNESS

3.1 Maximum Envelope Area
(Maximum Envelope to Floor Area Ratio)

	7851	ft ²
	2.62	

4. SOLAR PROTECTION

4.1.1 Maximum Whole Window SHGC

	NR
--	----

4.4.1 Projection Factor for Fixed Overhangs

	NR
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5. HEAT TRANSMISSION

5.1.1a Fenestration/Openings

Maximum Whole Component U-Value	0.18	(BTU/h.ft ² .°F)
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5.1.1b Walls & Overhang Floors

Minimum Effective R-Value	41	(ft ² .°F.h/BTU)
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5.1.1c Roofs, Ceilings

Minimum Effective R-Value	71	(ft ² .°F.h/BTU)
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5.1.1d Whole Slab Foundations & Below-Grade Walls and Floors of Conditioned Basements and Crawl Spaces

Minimum Effective R-Value	20	(ft ² .°F.h/BTU)
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5.1.1e Ceilings of Unconditioned Basements or Crawl Spaces, and Pier and Beam Floors

Minimum Effective R-Value	26	(ft ² .°F.h/BTU)
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6. MOISTURE RISK LIMITATION

6.2.1 Minimum Fenestration Condensation Resistance

	62%
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7. MECHANICAL VENTILATION

7.2.1 Minimum Sensible Recovery Efficiency, Heating Mode

	79%
--	-----

7.2.2 Minimum Total Recovery Efficiency, Cooling Mode

	NR
--	----

7.2.5 Maximum Total Length of Fresh Air Ducts to Outside

	31	ft
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8. MECHANICAL SYSTEMS

Select System Type

Air Source Heat Pump

8.2 System Efficiency

Minimum COP @ 5F	1.8
Minimum SEER	15.0

*NR = No Requirement
For further details, please see the phius 2021 CORE Prescriptive Checklist.

Phius CORE Prescriptive 2021

The Phius CORE Prescriptive program is limited to single family detached residences, townhomes, and duplexes.

<https://www.phius.org/phius-core-prescriptive-2021-checklist>

- Phius CORE Prescriptive 2021 Checklist - V2.6 - 07/2022									
Navigate to Endnotes	*To view all content in this checklist, make sure to 'enable macros'*				NR = 'No Requirement'				
	Required input cells.		Requirement met.	Calculated.	Threshold	Input 'X' for verification in columns R-U.			
	Required dropdown menu inputs.		Requirement not met.	Calculated from another sheet.		Submittal column [U] is for confirmation of document location/file name.			
Instructions: Use the [+] icon on the far left of the screen to expand and view built in compliance calculators.									
0 Project Information									
1 General					Design Verified	Rater Verified	N/A	Submittal	
2 Air-Tightness					Design Verified	Rater Verified	N/A	Submittal	
3 Compactness					Design Verified	Rater Verified	N/A	Submittal	
4 Solar Protection					Design Verified	Rater Verified	N/A	Submittal	
5 Thermal Enclosure					Design Verified	Rater Verified	N/A	Submittal	
6 Moisture Risk Limitation					Design Verified	Rater Verified	N/A	Submittal	
7 Mechanical Ventilation³³					Design Verified	Rater Verified	N/A	Submittal	
8 Mechanical Systems					Design Verified	Rater Verified	N/A	Submittal	
9 Lighting, Appliances & Water Heating					Design Verified	Rater Verified	N/A	Submittal	
10 Electric Vehicle Ready⁴⁶					Design Verified	Rater Verified	N/A	Submittal	
E Endnotes									
1 Attached dwellings are limited to those with vertical partitions only and no common spaces.									
2 For attached dwellings, one checklist may be used for a set of multiple identical dwelling units.									
3 Applicable program version based on time of PHIUS contract.									
4 For additional requirements see phius Certification Guidebook Sections 3 & 4, Appendix G-2.3, ENERGY STAR Certified Homes National Rater Field Checklist Sections 2 and 4, PHIUS+ Single-Family QA Workbook Sections, Building Envelope, Sections 3 and 4.									
5 Preliminary blower door test, as outlined in PHIUS+ Single Family QA Workbook Section 4.1, is required (not optional).									

Phius CORE Prescriptive 2021

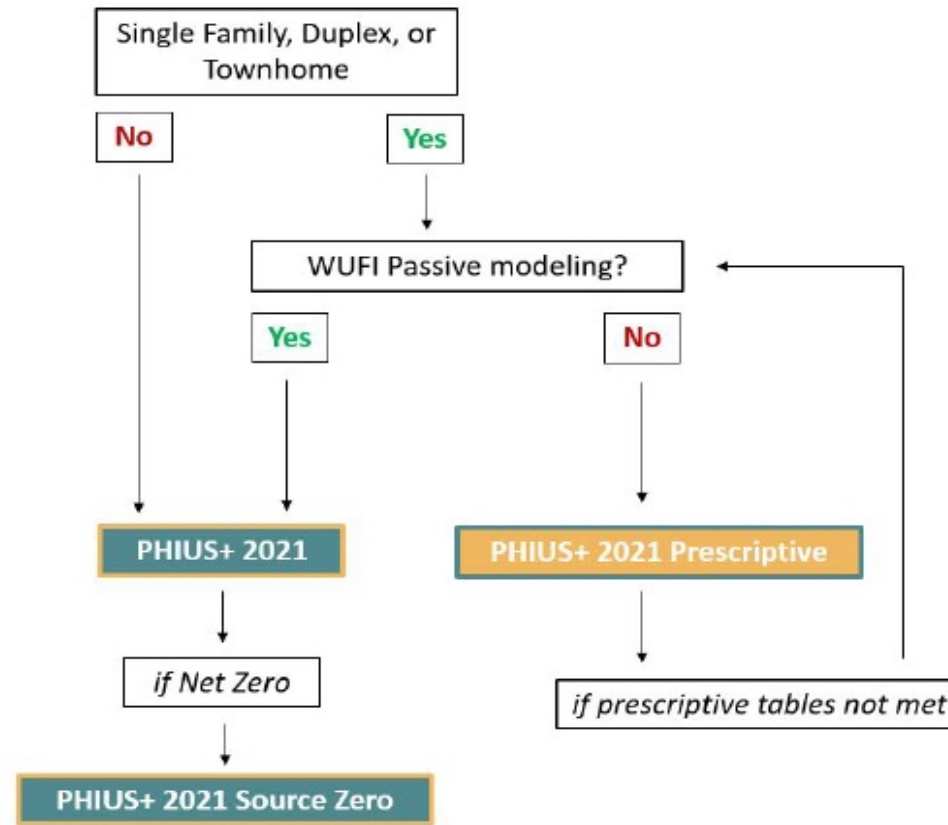


Figure 1. Certification Options. All three are climate-specific. Fossil fuel combustion is only allowed for regular PHIUS+ 2021, and electrification readiness is required.

Prerequisites for Phius Certified Raters

EPA Energy Star Rater Partner

Join ENERGY STAR as a Residential New Construction Partner

Becoming an ENERGY STAR partner is easy. Simply fill out an ENERGY STAR Partnership Agreement by following the appropriate link below. There is no cost to partner with ENERGY STAR or use ENERGY STAR promotional materials.

SINGLE-FAMILY HOMEBUILDERS, MULTIFAMILY BUILDERS AND DEVELOPERS, AND FACTORY BUILDERS/PLANTS ▶

RESIDENTIAL ENERGY RATING COMPANIES (e.g., HOME ENERGY RATERS, HERS RATERS, PROVIDERS) ▼

This Partnership Agreement is applicable to trained and certified professionals who plan to provide the energy analysis and on-site inspections/testing for site-built ENERGY STAR certified homes or multifamily apartment/condo units, under the oversight of an EPA-recognized Home Certification Organization (HCO) or Multifamily Review Organization (MRO).

To complete your Partnership Agreement, you will need to:

1. Review the [ENERGY STAR Partnership Agreement Terms and Commitments](#).
2. Determine a Signatory for your ENERGY STAR Partnership Agreement – This should be a representative of your organization who is authorized to bind the organization to the terms and commitments of the Agreement.
3. Upload Training Certificates – Each Energy Rating Company partner must have at least one certified home energy rater on-staff that has also completed mandatory ENERGY STAR-specific training. A valid training certificate must be uploaded as part of the Partnership Agreement process. For more information: [ENERGY STAR Residential Program Training Requirements](#).
4. Identify your Verification Oversight Organization or Multifamily Review Organization – You will be required to select the Home Certification Organization, rating provider, and/or Multifamily Review Organization that you will be initially working with, depending on how you are participating. Note that ENERGY STAR will verify your selection with the organization that you identify prior to approving your Partnership Agreement.

Energy Rating Company partners may also take advantage of:

EPA's Indoor airPLUS Program

This is a complementary labeling program to the ENERGY STAR Residential New Construction program that recognizes newly built homes that include a comprehensive set of indoor air quality measures. Energy Rating Companies are also eligible to verify homes for this program. Visit the [Indoor airPLUS website](#) for more information about program requirements.

The option to partner with the Indoor airPLUS program will be available as part of the ENERGY STAR partnership application process. If your organization is already an ENERGY STAR partner and would like to sign an Indoor airPLUS Partnership Agreement, please log in to your [My ENERGY STAR Account](#).

BEGIN APPLICATION →

UTILITIES AND OTHER PROGRAM SPONSORS ▶



Find Products

Save at Home

New Homes

About

Recursos en Español

Partner Resources



Prerequisites for Phius Certified Raters

EPA Energy Star Rater Partner

- https://www.energystar.gov/partner_resources/join_energy_star/new_home_construction
- Indoor airPLUS PA is part of the Energy Star Rater partner sign up

Prerequisites for Phius Certified Raters

DOE ZERH Partner

- <https://www5.eere.energy.gov/buildings/residential/register>

The screenshot shows the 'Register for the DOE Zero Energy Ready Home' form. The header includes the U.S. Department of Energy logo and the text 'Energy Efficiency & Renewable Energy'. The page title is 'Building Technologies Office'. The breadcrumb trail is 'Home » Residential Buildings » DOE Zero Energy Ready Home'. The main heading is 'Register for the DOE Zero Energy Ready Home' with the instruction 'Complete the online registration to become a DOE Zero Energy Ready Home partner.' A red asterisk indicates 'Required Fields'. The form is divided into two sections: 'Contact Information' and 'Primary Contact'. The 'Contact Information' section includes fields for Organization Name (complete legal name - i.e. Acme, LLC), Organization Type (dropdown), Parent Organization (if applicable), Street Address (i.e. '123 Main St.' - NO CITY, NO STATE), City, State (dropdown), Zip, Primary Phone Number (numbers only, no hyphens or dots), and Website Address (complete - 'http://www.example.com'). The 'Primary Contact' section includes a radio button for 'Authorized Signature?' (Yes/No), and fields for First Name and Last Name.

Phius Certified Rater Resources:


- Phius 2021 v3.02 Certification Guidebook – July 2021*
- Phius Quality Control Workbook v4.1 for SF Projects
- Check to see if project is Pre-certified prior to construction


Phius 2021

PASSIVE BUILDING STANDARD

CERTIFICATION GUIDEBOOK


Version 3.02 | July 2021





53 W. Jackson Blvd. Suite 1462
Chicago, IL 60604 | (312) 561-4588

certification@phius.org
www.phius.org



Phius Single Family Quality Assurance Workbook - v4.2 (November 2021)

Project Name	Project Permit Date	Phius Project	Phius Certified	Rater Company	CPRC Name	CPRC Company Name
Street Address	City	State/Province	Zip Code	County	Builder Company Name	Builder Responsible
Total # Building Units	HVAC Company name	HVAC Responsible Individual	HVAC Approval/Inspection in drawing with owner (aka: SEER)	MECHANICAL YAC Installation completed	EPA ENERGY STAR / DOE ZERH Certification required?	HVAC Certification must be ESTAR accredited?
Builder or HVAC contractor cert. (ESTAR)				Yes	CPRC Certification Path	Phius SEER Database

Welcome to the Phius Quality Control Workbook for Single Family Projects v4.2!

Certification Criteria
The Phius Certification process for single family projects includes energy modeling and design excellence performed by a Certified Passive House Consultant (CPHC) to demonstrate compliance with Phius program energy performance metrics, as well as onsite verification of all critical project energy features by a Phius Certified Rater.

Additionally, all projects must meet the modeling criteria and be certified under the EPA ENERGY STAR Single-Family New Homes (ESTAR), DOE Zero Energy Ready Home (ZERH), and EPA Indoor airPLUS (IAP) program. Projects must be certified under these complementary programs in order to help ensure that projects meeting Phius Certification are not only energy efficient, but also a desirable, comfortable and healthy building.

For full program requirements, please see the [Phius Certification Workbook \(http://www.phius.org/Phius-Certification-for-Buildings-projects/\)](http://www.phius.org/Phius-Certification-for-Buildings-projects/).

Using This Workbook
The goal of this workbook is to provide a single, organized data collection form that shall be used by Phius Certified Raters to document required onsite verification measures that are required for Phius Certification. In use, the workbook encompasses the various program requirements of the Phius certification, including the key practices for building envelope design/installation, HVAC design/installation, domestic hot water distribution, moisture durability management, and indoor air quality. In addition, information regarding testing protocols, compliance requirements and links to outside information are included throughout the document using the red "template" flags that are embedded at the top right of various cells in the workbook.

This workbook shall be used only for Phius projects encompassing single-family homes and small attached residential developments (duplexes, townhouses, etc). For multi-unit or commercial projects, the Phius Multi-unit Checklist shall be used and certified by a Phius Certified Verifier. ggg

There are six workbooks to complete for the overall build:

Workbook	Responsible parties for completion; workbooks are filled by:
Building Envelope	Phius Certified Rater
MECHANICAL	Phius Certified Rater
Water, Air, & Hum	Phius Certified Rater
Indoor Air Quality & Moisture	Phius Certified Rater
Water Management & LEED	Builder AND/OR Phius Certified Rater

Data entry cells for the Rater, builder, HVAC contractor, or draughts are in light blue. Calculated cells are in light grey. Do not change the calculation cells!

Phius Certified Raters are welcome to add their own custom sheets to this workbook for instance, to track project notes.

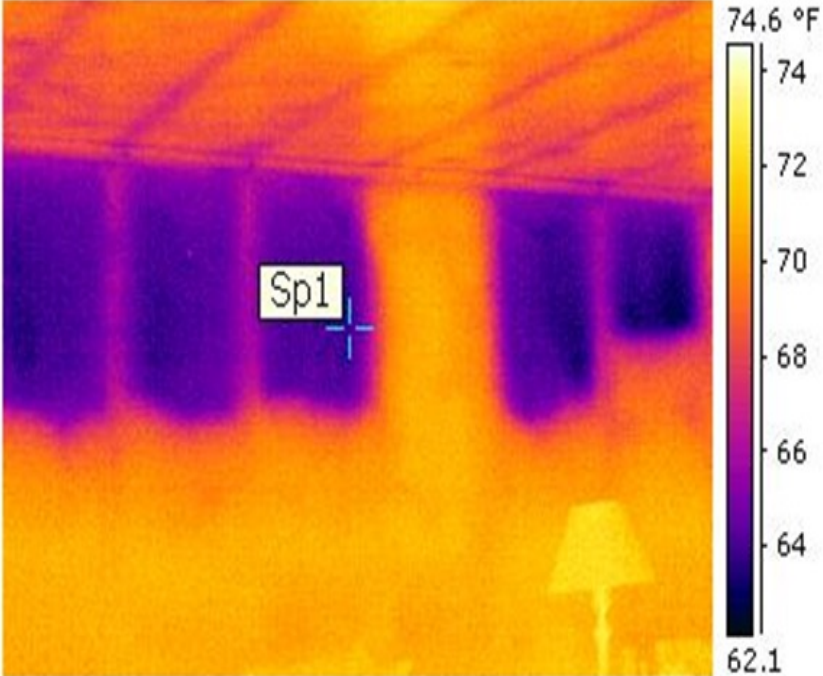
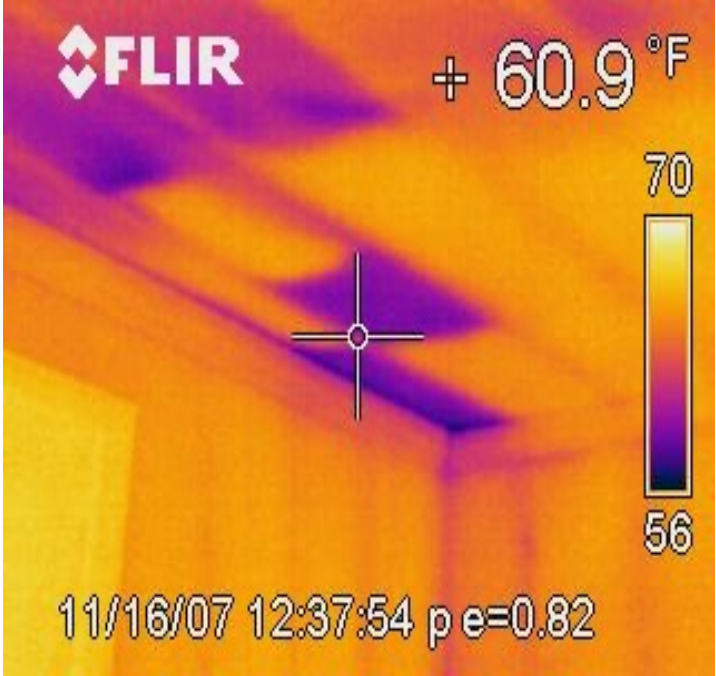
Questions regarding particular spreadsheet items should be directed first to the Phius Certified Rater for the project. For questions on the measures before certifying an entire building under Phius and verifying individual dwelling units within each building under ESTAR/ZERH, please contact the PHIUS at info@phius.org. For general questions regarding Phius Certification, please contact [www@phius.org](mailto:info@phius.org).

Footnotes
1) All projects located within the United States are California or Alaska will be required to use ESTAR and ZERH certifications, but must still meet all certification requirements.
2) Builders in the Phius Rater/Verifier Manual for projects will have an additional field of Raters to use as a Verifier on a project.

Why does Phius require these programs as prerequisites?

**Phius requires these
programs as a means of
Quality Control for projects.
Why?**

Stuff Happens.....



Stuff Happens.....



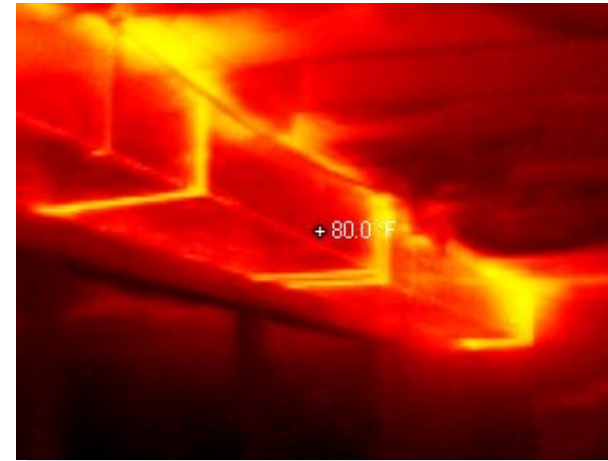
Phius Certified Rater Training



Restricted air flow



Panned Floor Joists

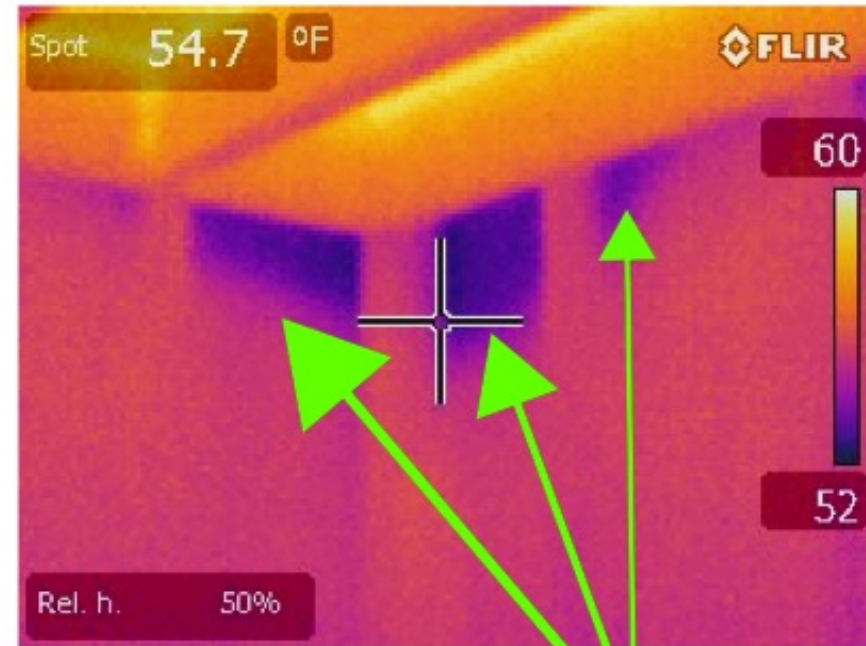


Photos courtesy of A. Lisanti Integral Building & Design

Phius Certified Rater Training

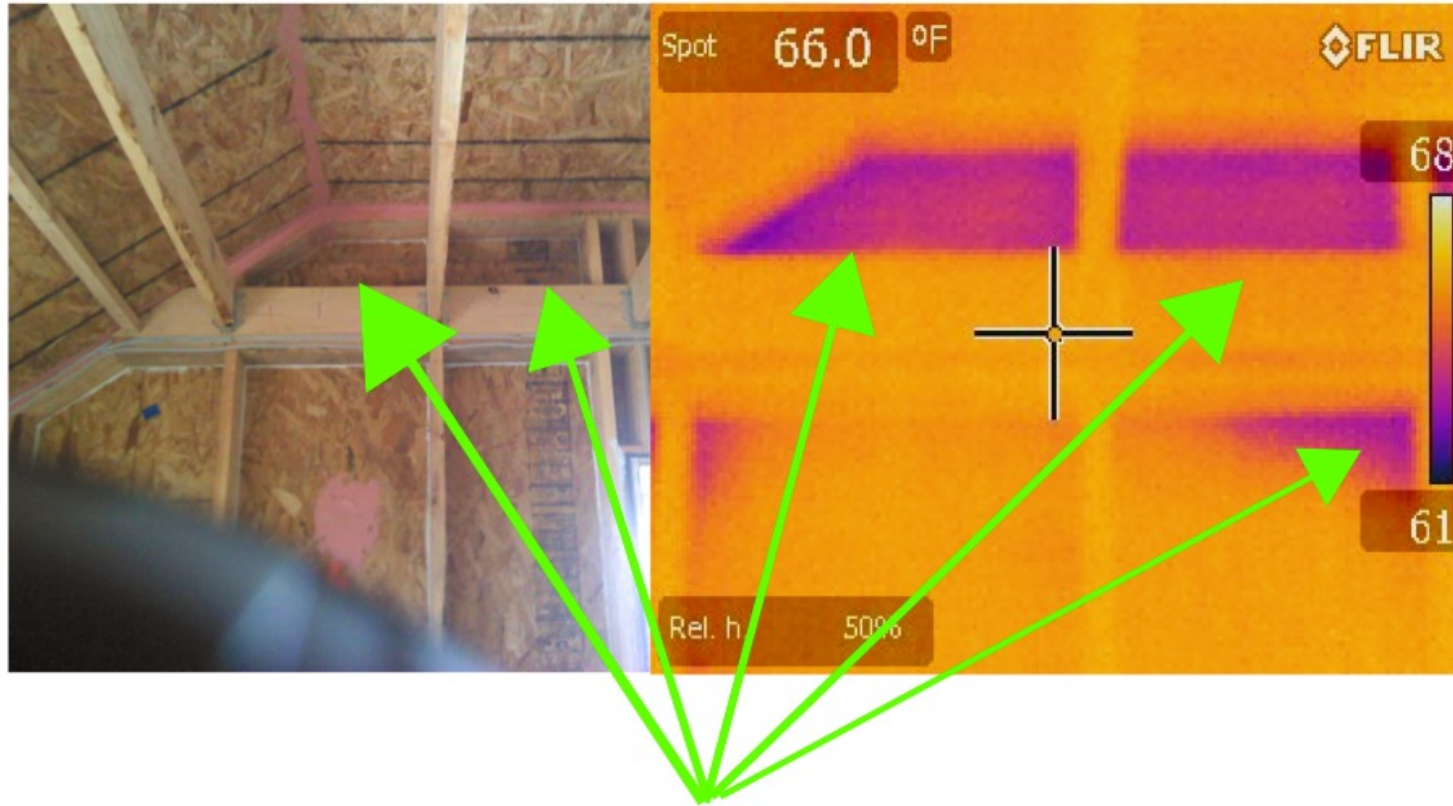


When you cannot see the insulation, it's very important to check with an IR Camera



Insulation did not fill the cavity completely.

Phius Certified Rater Training



These areas didn't have insulation!

Phius Certified Rater Training



Photos courtesy of A. Lisanti Integral Building & Design

High performance Team

Owner

GC/CM

Engineer/Architect

Phius Certified Consultant (CPHC®)

Other consultants (LEED, Enterprise
Green, etc..)

T&B contractor

Phius Certified Rater



**Consultant cannot be the Rater
Rater cannot be the Consultant!**

Getting Started

- Define your niche
- Fully integrated team member
 - Collaboration
 - Offer strategies for building performance
 - Share experiences
 - Help avoid pitfalls/problems
- Strict third-party verification
 - Limited scope

Know your role!

Pre-certification

Good to know but not required-

- Compliance Path – Source Zero or Phius Core
- Mandatory energy performance targets per climate-specific Phius 2021 requirements
- Building Envelope surface area – HERS Model vs. WUFI – should match

Pre-certification Phius 2021

Air-Tightness requirements:

Bldgs.. 5 stories and above with Non-combustible Construction:

$q_{50} \leq 0.080$ CFM50/ft² or $q_{75} \leq 0.100$
CFM75/ft² of gross envelope area

All other Bldgs. – Phius Core & Source
Zero:

$q_{50} \leq 0.060$ CFM50/ft² or $q_{75} \leq 0.08$
CFM75/ft² of gross envelope area

Phius 2021 Prescriptive:

$q_{50} \leq 0.040$ CFM50/ft²

Please indicate Building Configuration On
the Report -taped/untaped
Dwelling Unit Compartmentalization 0.30
CFM/SF

Added Quality/ Value

- EPA & DOE programs require on-site verification and QA
- EPA & DOE programs go beyond the envelope
 - Indoor air quality / durability
 - Enhanced HVAC & DHW design and commissioning
 - Designed for “zero energy” future

ENERGY STAR Single-Family New Homes
National Program Requirements, Version 3.1 (Rev. 11)

The following site-built or modular¹ homes are eligible to earn the ENERGY STAR:

**ENERGY STAR Single-Family New Homes
National HVAC Design Report, Version 3 / 3.1 (Rev. 11)¹**

**ENERGY STAR Single-Family New Homes
National HVAC Commissioning Checklist, Version 3 / 3.1 (Rev. 11)^{1,2}**

**ENERGY STAR Single-Family New Homes
National Rater Field Checklist, Version 3 / 3.1 (Rev. 11)**

Home Address: _____ City: _____ State: _____ Permit Date: _____

**ENERGY STAR Single-Family New Homes
National HVAC Commissioning Checklist, Version 3 / 3.1 (Rev. 11)^{1,2}**

HVAC Commissioning Contractor Responsibilities:

The commissioning contractor must be credentialed by an HVAC oversight organization to complete this checklist. One checklist must be completed and signed by the commissioning contractor for each HVAC system that is commissioned.

The completed checklist for each commissioned system, along with the corresponding National HVAC Design Report, shall be retained by the contractor for a minimum of three years for quality assurance purposes. Furthermore, the contractor shall provide the completed checklist to the builder, the Rater¹ responsible for certifying the home, and the HVAC oversight organization upon request.

**ENERGY STAR Single-Family New Homes
National Rater Field Checklist, Version 3 / 3.1 (Rev. 11)**

Home Address: _____ City: _____ State: _____ Permit Date: _____

Item	Pass/Fail	Notes
1.1 Contractor ID		
1.2 Organization		
1.3 Builder client		
1.4 Home address		
1.5 National HVAC		
1.6 Area that is inspected		
1.7 House plan, if available		
2. Refrigerant Charge		
2.1 Outdoor ambient air dry-bulb temperature		
2.2 Return-side air temperature		
2.3 Liquid line pressure		
2.4 Liquid line temperature		
2.5 Suction line pressure		
2.6 Suction line temperature		
2.7 Condenser coil temperature		
2.8 Subcooling		
2.9 OEM subcooling		
2.10 Subcooling		
2.11 Evaporator coil temperature		
2.12 Superheat		
2.13 OEM superheat		
2.14 Superheat		
2.15 Return-side air temperature		
2.16 An OGV test is required		
3. Indoor HVAC		
3.1 The house is heated		
3.2 Duct leakage		
3.3 Duct leakage		
3.4 Air sealing		
3.5 Measured envelope		
3.6 Measured floor		
3.7 Measured interior		
3.8 Measured exterior		
3.9 Measured interior		
3.10 Measured exterior		
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3.99 Measured interior		
3.100 Measured exterior		

Added Quality/ Value

EPA & DOE programs require on-site verification and QA



How to Find Indoor airPLUS Compliant Low-Emission Products

The Low-Emission Materials requirements contained in Section 6 of the Indoor airPLUS Construction Specifications address composite wood products, interior paints and finishes, and carpets and carpet adhesives used in the construction of Indoor airPLUS qualified homes. Products meeting the referenced standards are generally widely available in the market. This document is intended to help builders, designers, and Raters identify and locate compliant products.

Basic Information:

1. Your product supplier and/or product manufacturers are likely to be the best source of information about low emission products.
2. Many of the certifications and labels identified below meet multiple and/or overlapping standards. A single listed label or certification for a specific product is sufficient to comply with Indoor airPLUS requirements.
3. The certification marks displayed in the table below are **EXAMPLES** only. Other certifications that meet the underlying referenced standards may also be compliant with the Indoor airPLUS requirements. In addition, the listed programs and standards may have different or additional labels, and other certification marks may be used by the programs listed below. For more background on these standards and labels, see "Additional Information on Referenced Standards and Programs" on pages 7-10.
4. Use caution in selecting "green" product labels. Other labels may claim to be healthier or more eco-friendly, but they may not comply with the Indoor airPLUS Construction Specifications.

To request that other compliant certifications or programs be added to this resource or for additional questions about these or other Indoor airPLUS Construction Specifications, please contact indoor_airPLUS@epa.gov. For complete information about Indoor airPLUS, visit the Indoor airPLUS website at www2.epa.gov/indoorairplus.



VERSION 1 (REV. 04) Indoor airPLUS CONSTRUCTION SPECIFICATIONS



February 2018
www.epa.gov/indoorairplus

Indoor Air Quality (IAQ)

EPA Indoor Air Quality Criteria
Indoor airPLUS Version 1 (Rev. 04)
Verification Checklist

Home Address: _____ City: _____ State: _____ Zip: _____

Climate Zone [1-4]: _____ 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 VI	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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Moisture Control	1.1 Drain or sump pump installed in basements and crawlspaces. In EPA Radon Zone 1, check walls and floors. Exception Applied: <input type="checkbox"/> Step-on-grade foundation <input type="checkbox"/> Free-draining soils	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	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: <input type="checkbox"/> Step-on-grade foundation <input type="checkbox"/> Free-draining soils <input type="checkbox"/> Dry climate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1.4 Basements/crawlspaces insulated, sealed and conditioned. Exception Applied: <input type="checkbox"/> 100-year flood zone <input type="checkbox"/> Marine climate <input type="checkbox"/> Dry climate <input type="checkbox"/> Crawlspace sealed with capillary break and active dehumidification <input type="checkbox"/> Raised pier foundation with no walls	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1.7 Protection from water splash damage if no gutters. Exception Applied: <input type="checkbox"/> Rainwater harvesting system <input type="checkbox"/> Dry climates	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1.11 Supply piping in exterior walls insulated with pipe wrap. Exception Applied: <input type="checkbox"/> Dry climate AND climate zone 1-3 <input type="checkbox"/> Air barrier insulation in wall cavity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.14 Hero-surface flooring in kitchens, baths, entry, laundry, and utility rooms.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Radon	2.1 Radon-resistant features installed in Radon Zone 1 homes in accordance with Construction Specification 2.1. Exception Applied: <input type="checkbox"/> Perimeter pipe loop in lieu of full aggregate (dry climate) <input type="checkbox"/> Manufactured home with raised pier foundation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	3.2 Control-proof rodents/bird screens installed at all openings that cannot be fully sealed. (Not required for clothes dryer vents.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Pests	4.1 Equipment selected to keep relative humidity < 60% in "warm-humid" climates. Exception Applied: <input type="checkbox"/> Climate zones 4-8, 3B, 3C and portions of 3A and 2B	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4.2 Duct systems protected from construction debris AND no building cavities used as air supplies or returns.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4.3 No air-handling equipment or ductwork installed in garage.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4.6 Clothes dryers vented to the outdoors or plumbed to a drain according to manufacturer's instructions.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
HVAC Systems	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. Emissions standards met for fuel-burning and space-heating appliances.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	5.1 Identify appliance type: <input type="checkbox"/> Masonry heater <input type="checkbox"/> Factory-built wood-burning fireplace <input type="checkbox"/> Wood stove <input type="checkbox"/> Pellet stove <input type="checkbox"/> Natural gas/propane fireplace Appliance model name/number: _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Combustion Ventilation	5.2 CO alarms installed in each sleeping zone (e.g., common hallway) according to NFPA 720.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	5.3 Multifamily buildings: Smoking restrictions implemented AND ETS transfer pathways minimized.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	5.4 Attached garages: Door closer installed on all connecting doors. Attached garages: In homes with exhaust-only whole-house ventilation EITHER <input type="checkbox"/> 70 cfm exhaust fan installed in garage OR <input type="checkbox"/> Pressure test conducted to verify the effectiveness of the garage-to-house air barrier.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6.1 All composite wood products certified low-emission. See spec.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Indoor airPLUS Version 1 (Rev. 04) Verification Checklist (February 2018) 1

Added Quality/ Value

- Version 1 Rev 4
Radon mitigation in EPA Radon Zone 1

Changes coming to this Program in 2022



VERSION 1 (REV. 04)
Indoor airPLUS
CONSTRUCTION SPECIFICATIONS



February 2018
www.epa.gov/indoorairplus

Indoor Air Quality (IAQ)

Added Quality/ Value

EPA & DOE programs require on-site verification and QA



DOE Zero Energy Ready Home
National Program Requirements (Rev. 07)
May 1, 2019

To qualify as a DOE Zero Energy Ready Home, a home shall meet the minimum requirements specified below, be verified and field-tested in accordance with HERS Standards by an approved verifier, and meet all applicable codes.¹ Builders may meet the requirements of either the Performance Path or the Prescriptive path to qualify a home.²

The following homes are eligible for DOE Zero Energy Ready Home qualification:

- Detached dwelling units³ (e.g. single family homes)
- Dwelling units³ in any multifamily building with 4 units or fewer
- Dwelling units³ in multifamily buildings with 3 stories or fewer above-grade⁴
- Dwelling units³ in multifamily buildings with 4 or 5 stories above-grade⁴

Dwellings in eligible multifamily buildings as listed above may be served by central heating, cooling, or hot water⁵ systems. Partners are also advised that DOE is developing a revised program design for multifamily dwellings, consistent with the ENERGY STAR Multifamily New Construction program, which will be available for use (but not yet required) on or after March 1, 2020.

Homes may qualify for DOE Zero Energy Ready Home using either the Prescriptive Path or Performance Path in all locations except CA, for which regional program requirements have been developed. Note that compliance with these guidelines is not intended to imply compliance with all local code requirements that may be applicable to the home to be built.

DOE Zero Energy Ready Home Prescriptive Path

The prescriptive path provides a single set of measures that can be used to construct a DOE Zero Energy Ready Home labeled home. Modeling is not required, but no tradeoffs are allowed. Follow these steps to use the prescriptive path:

1. Assess eligibility by using the number of bedrooms in the home to be built to determine the conditioned floor area (CFA) of the Benchmark Home, Exhibit 3. If the CFA of the home to be built exceeds this value, the performance path shall be used.
2. If the prescriptive path is eligible for use based on the prior step, build the home using the mandatory requirements for all labeled homes, Exhibit 1, and all requirements of the DOE Zero Energy Ready Home HERS Target Home (Exhibit 2). The rigor of the specifications in Exhibit 2 shall be met or exceeded.
3. Verify that all requirements have been met using an approved verifier.⁶

All homes certified through the Prescriptive Path shall be submitted to DOE (email: enr@doe.gov).

DOE Zero Energy Ready Home Performance Path

While all mandatory requirements for labeled homes in Exhibit 1 shall be met, the performance path provides flexibility to select a custom combination of measures that meet the performance level of the DOE Zero Energy Ready Home HERS Target Home (Exhibit 2). Modeling is required, but measures can be optimized for each particular home or builder. Follow the steps below to use the performance path with RESNET-accredited Home Energy Rating Software programs:

1. The HERS Index of the DOE Zero Energy Ready Home Target Home is determined. The DOE Zero Energy Ready Home Target Home is identified in the home that will be built, except that it is configured with the energy efficiency features of the DOE Zero Energy Ready Home Target Home as defined in Exhibits 1 and 2. The HERS Index of the Target Home is automatically calculated in accordance with the RESNET Mortgage Industry National Home Energy Rating Standards.

2. A size modification factor is next calculated using the following equation:
Size Modification Factor = $(CFA_{\text{Benchmark Home}} / CFA_{\text{Home to be Built}})^{1.16}$, but not to exceed 1.0

Where:
 $CFA_{\text{Benchmark Home}}$ = Conditioned Floor Area of the Benchmark Home, using Exhibit 3

Effective for Homes Permitted Starting June 1, 2019

Revised May 1, 2019

Page 1 of 11

**DOE
Zero Energy Ready Home
PV-Ready Checklist**

DOE Zero Energy Ready Home National Program Requirements Mandatory Requirement 7 (Renewable Ready) shall be met by any home certified under the DOE Zero Energy Ready Home program, only where **all three conditions** of the following conditions are met. If any of these three conditions is not met, the home is exempt from requirements contained in the PV-Ready checklist.

1. Location, based on zip code has at least 5 kWh/m²/day average daily solar radiation based on annual solar insolation using PVWatts online tool: http://nrel.gov/ia/insol/nrel.gov/PVWatts_View/index.html; AND;
2. Location does not have significant natural shading (e.g., trees, tall buildings on the south-facing roof, AND;
3. Home as designed has adequate free roof area within +/-45° of true south as noted in the table below.

Conditioned Floor Area of the House (sq. ft.)	Minimum Roof Area within +/- 45° of True South for PV-Ready Checklist to Apply (ft ²)
< 2000	110
< 4000	220
< 6000	330
> 6000	440

Note:
 > If a solar photovoltaic system is included with the home, then compliance with the Consolidated RERH checklist is not required.

These requirements were adapted from the EPA's Renewable Energy Ready Home Solar Photovoltaic Specification Guide (RERHPV Guide). For further guidance on any of the above items, this checklist notes the section of the guide. This guide can be accessed on the DOE Zero Energy Ready Home program website at http://www1.eere.energy.gov/buildings/residential/pdfs/nemr_pv_guide.pdf

Exhibit 1: DOE Zero Energy Ready Home Mandatory Requirements for All Labeled Homes

Area of Improvement	Mandatory Requirements
1. ENERGY STAR for Homes Baseline	<input type="checkbox"/> Certified under ENERGY STAR Qualified Homes Program Version 3, 3.1, or 3.2 (depending on state), or under ENERGY STAR Multifamily New Construction program Version 1.0 or 1.1 (depending on state) ^{9, 9, 10}
2. Envelope	<input type="checkbox"/> Fenestration shall meet or exceed ENERGY STAR requirements. See End Note for specific U, SHGC values, and exceptions. ¹¹ <input type="checkbox"/> Ceiling, wall, floor, and slab insulation shall meet or exceed 2015 IECC levels ^{12,13}
3. Duct System	<input type="checkbox"/> Duct distribution systems located within the home's thermal and air barrier boundary or an optimized location to achieve comparable performance. ¹⁴ <input type="checkbox"/> HVAC air handler is located within the home's thermal and air barrier boundary.
4. Water Efficiency	<input type="checkbox"/> Hot water delivery systems (distributed and central) shall meet efficient design requirements ¹⁵ or <input type="checkbox"/> Water heaters and fixtures shall meet efficiency criteria ¹⁶
5. Lighting & Appliances	<input type="checkbox"/> All installed refrigerators, dishwashers, and clothes washers are ENERGY STAR qualified. ¹⁷ <input type="checkbox"/> 80% of lighting fixtures are ENERGY STAR qualified or ENERGY STAR lamps (bulbs) in minimum 80% of sockets <input type="checkbox"/> All installed bathroom ventilation and ceiling fans are ENERGY STAR qualified
6. Indoor Air Quality	<input type="checkbox"/> Certified under EPA Indoor airPLUS ¹⁸
7. Renewable Ready	<input type="checkbox"/> Provisions of the DOE Zero Energy Ready Home PV-Ready Checklist are Completed ¹⁸

¹⁵ Hot water delivery systems in single family homes and distributed (individual water heater) systems in multifamily buildings meet the following efficiency requirements:

To minimize water wasted while waiting for hot water, the hot water distribution system shall store no more than 0.5 gallons (1.9 liters) of water in any piping/manifold between the hot water source and any hot water fixture. In the case of on-demand recirculation systems, the 0.5 gallon (1.9 liter) storage limit shall be measured from the point where the branch feeding the fixture branches off the recirculation loop, to the fixture itself. To verify that the system stores no more than 0.5 gallons (1.9 liters), verifiers shall calculate the stored volume using the piping or tubing inside diameter and the length of the piping/tubing. System options include manifold-fed systems; structured plumbing systems; core plumbing layouts, and on-demand recirculation systems. The following requirements apply to recirculation systems:

- a. Recirculation systems must be based on an occupant-controlled switch or an occupancy sensor, installed in each bathroom which is located beyond a 0.5 gallon stored-volume range from the hot water heater.
- b. Recirculation systems which operate based on "adaptive" scheduling, meaning that they "learn" the hot water demand profile in the home and adapt their operation to anticipate this profile, are permitted at this time, and do not require the use of occupant-controlled switches or occupancy sensors.
- c. Recirculation systems that are activated based solely on a timer and/or temperature sensor are not eligible.

No more than 0.6 gallons (2.3 liters) of water shall be collected from the hot water fixture before hot water is delivered. Only the fixture with the greatest stored volume between the fixture and the hot water source (or recirculation loop) needs to be tested. To field verify that the system meets the 0.6 gallon (2.3 liter) limit, verifiers shall first initiate operation of on-demand recirculation systems, if present, and let such systems run for at least 40 seconds. If an Adaptive Scheduling system cannot be "forced" into recirculation mode, contact DOE for further guidance. Next, a bucket or flow measuring bag (pre-marked for 0.6 gallons) shall be placed under the hot water fixture. The hot water shall be turned on completely and a digital temperature sensor used to record the initial temperature of the water flow. Once the water reaches the pre-marked line at 0.6 gallons (approximately 24 seconds for a lavatory faucet), the water shall be turned off and the ending temperature of the water flow (not the collection bucket) shall be recorded. The temperature of the water flow must increase by ≥ 10 °F. Under the DOE Zero Energy Ready Home program, the approved verifier may confirm compliance with these requirements.

Project Review

Project status

Design phase?

Pre-certified?

Plans

Air, vapor, WRBs

Insulated assemblies

Window performance and

locations

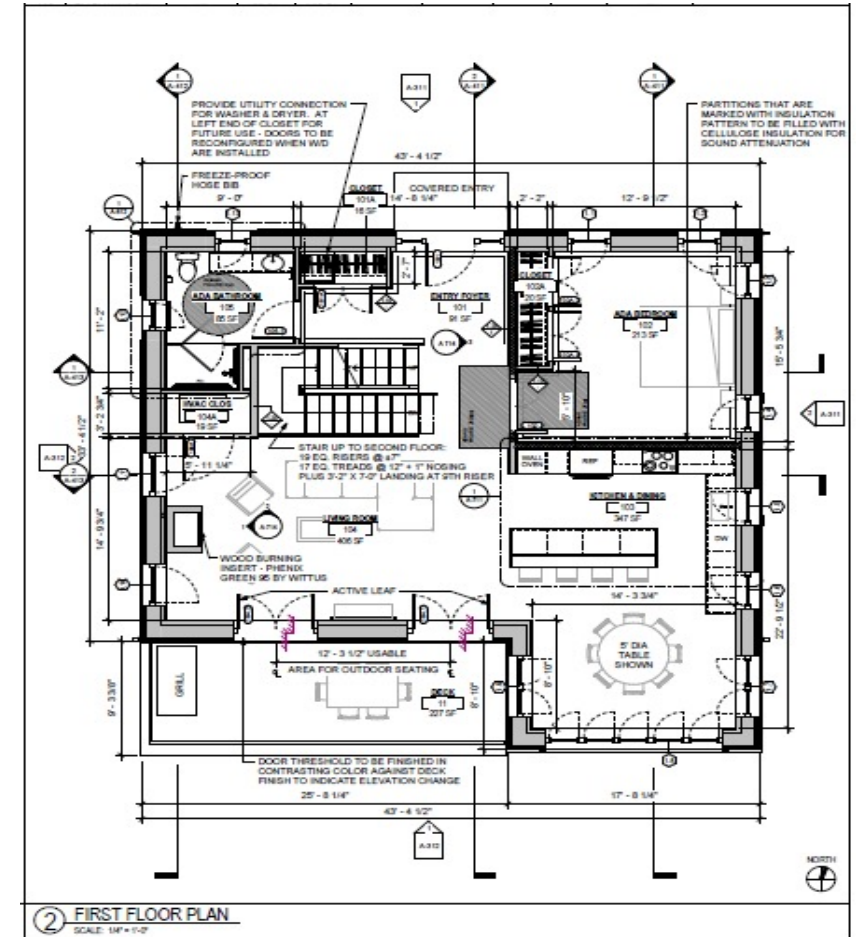


Image credit- River Architects

Project Review

Project status

Design phase?

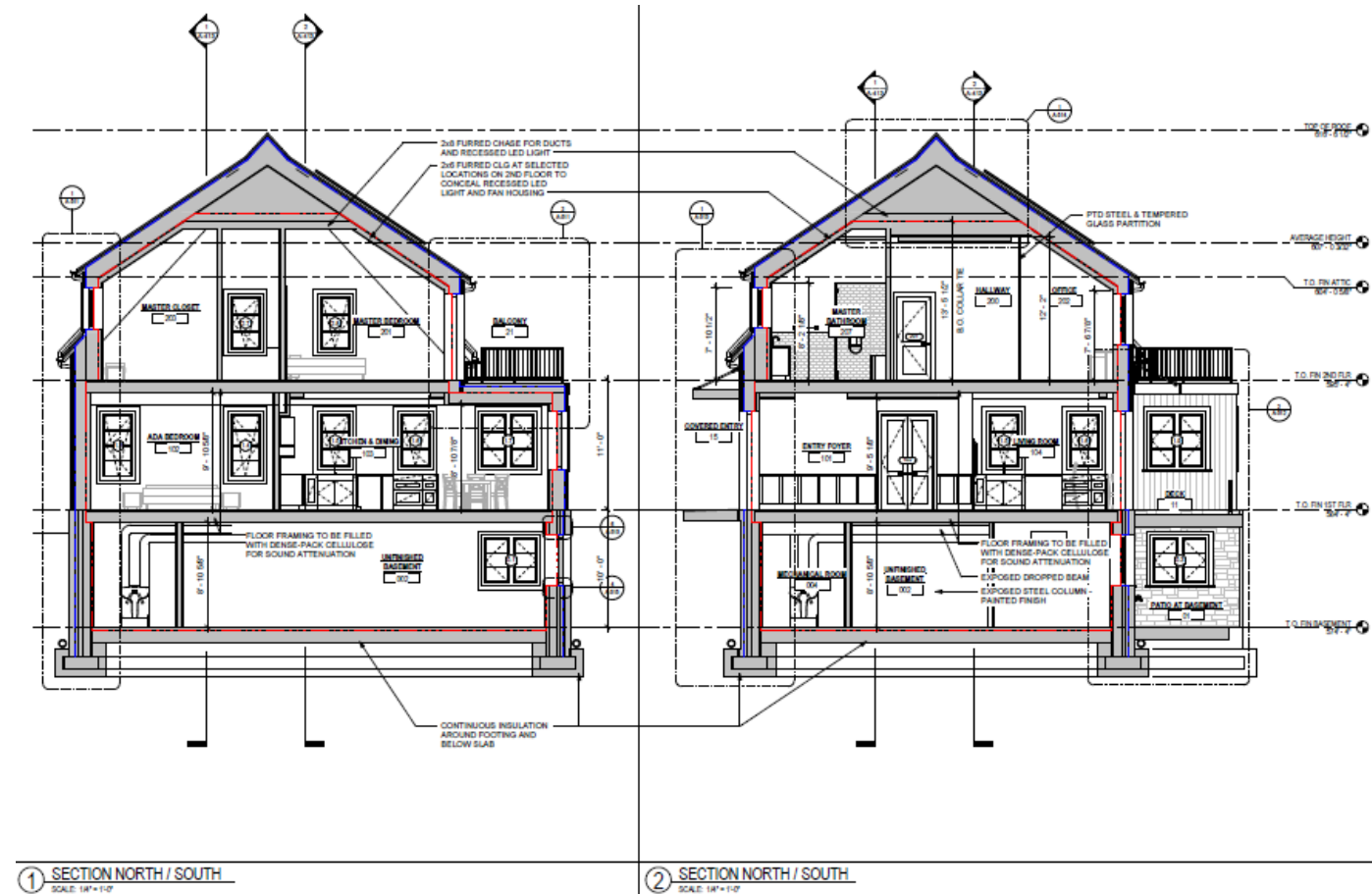
Pre-certified?

Plans

Air, vapor, WRBs

Insulated assemblies

Window performance and locations



Phius Certified Rater Training

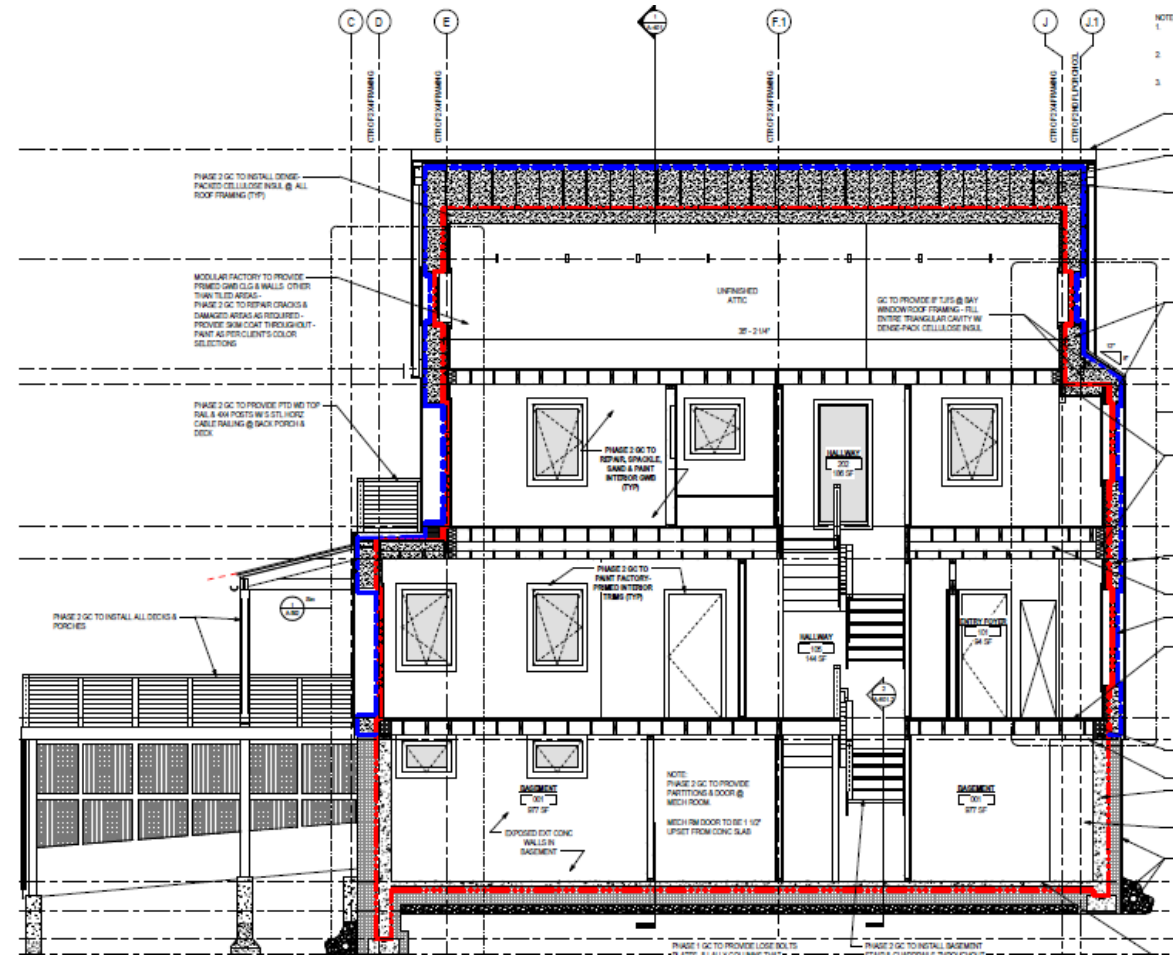


Image credit- River Architects

Phius Certified Rater Training

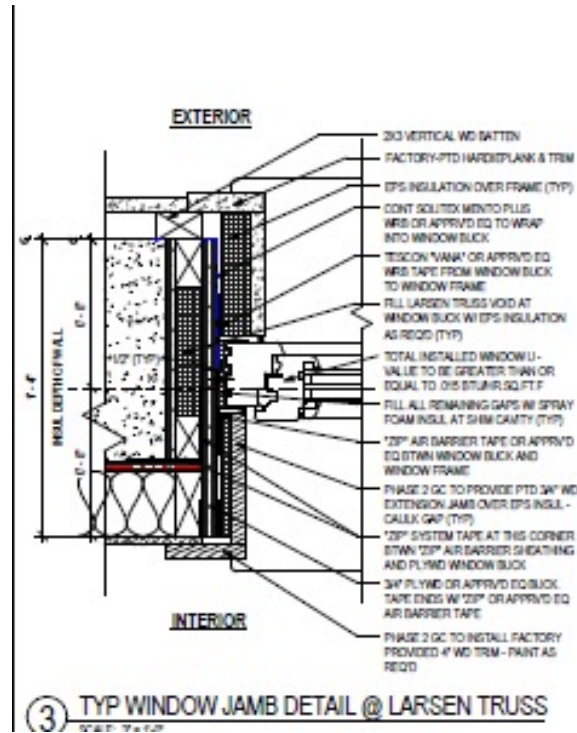


Image credit- River Architects



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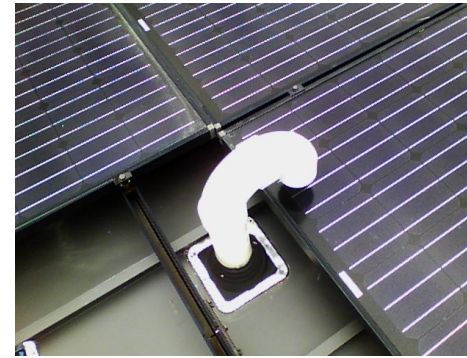
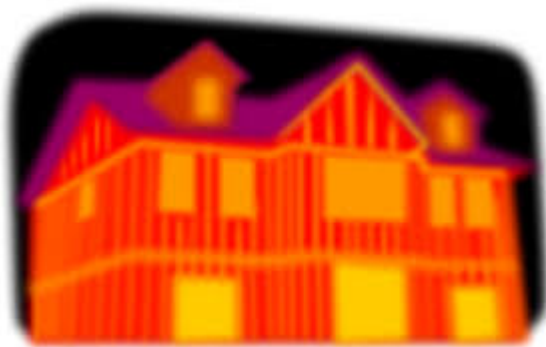
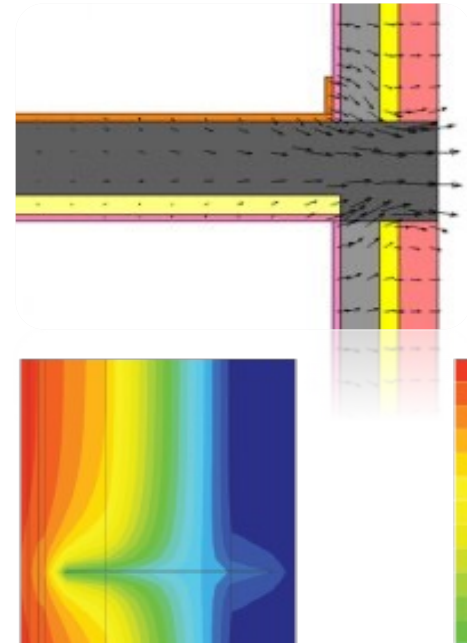
QA Workbook completion

6.1	Drawings check - describe any significant variations in construction from the construction drawings and specifications (insulation, window sizes, window performance, fixed shading etc.)
Rater Notes:	

QA Workbook completion

Details

- Thermal bridging / mitigation strategies
- Window shading strategies



QA Workbook completion: Specs

Mechanical
System types
Locations
Interactions

Lighting/pipe/duct layout

Appliances

IAP compliance

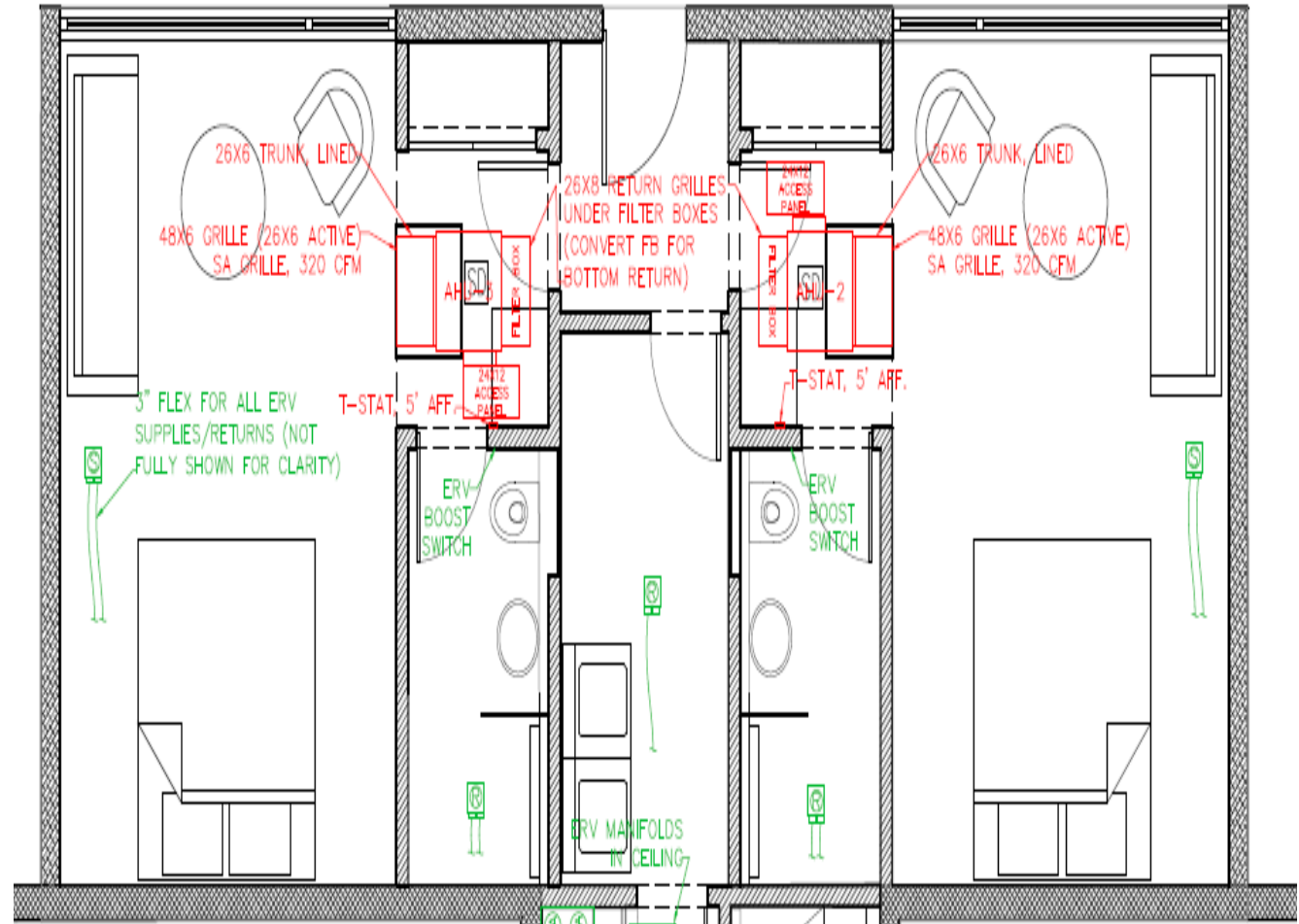


Image credit: Baukraft Engineering PLLC.

QA Workbook completion: Specs

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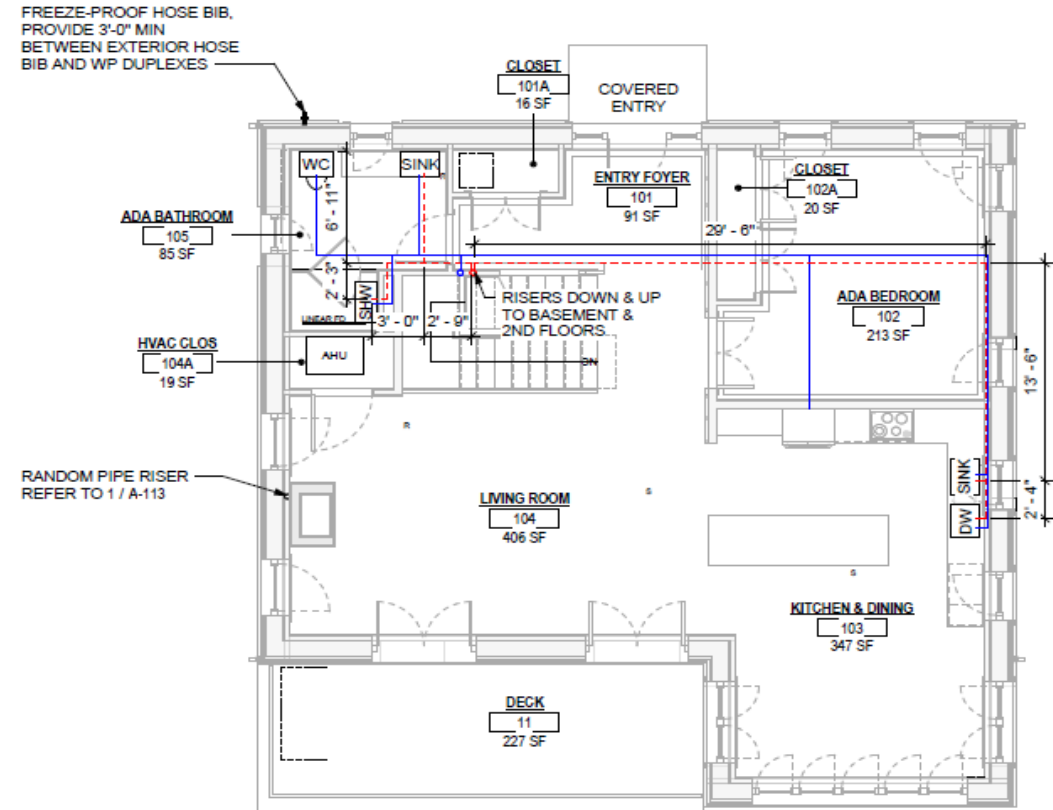


Image credit: Baukraft Engineering PLLC.

QA Workbook completion

- Program Checklists
- Energy Star v3.1 Rev 11
 - HVAC Design Report
 - Rater Design Review Checklist
 - HVAC Commissioning Checklist
 - Rater Field Checklist
- Indoor airPLUS Checklist

QA Workbook completion: Water Management Requirements

This is to be followed by the builder

Includes basic bulk water management steps: *drainage plane, flashings, capillary breaks, drain tile, etc..*

Much of this is “code” in many areas



ENERGY STAR Single-Family New Homes

National Water Management System Builder Reqs.¹, Vers. 3 / 3.1 (Rev. 11)

Builder Responsibilities:

- It is the exclusive responsibility of builders to ensure that each certified home is constructed to meet these requirements.
- While builders are not required to maintain documentation demonstrating compliance for each individual certified home, builders are required to develop a process to ensure compliance for each certified home (e.g., incorporate these requirements into the Scope of Work for relevant sub-contractors, require the site supervisor to inspect each home for these requirements, and / or sub-contract the verification of these requirements to a Rater²).
- In the event that the EPA determines that a certified home was constructed without meeting these requirements, the home may be decertified.

1. Water-Managed Site and Foundation

- 1.1 Impermeable surfaces (e.g., patio, porch, or plaza slabs, sidewalks, ramps, driveways) sloped ≥ 0.25 in. per ft. away from home to edge of surface or 10 ft., whichever is less.¹
- 1.2 Back-fill has been tamped, and permeable surfaces sloped ≥ 0.5 in. per ft. away from home for ≥ 10 ft. Alternatives in Footnote.³
- 1.3 Capillary break beneath all slabs (e.g., slab on grade, basement slab) except crawlspace slabs using either: ≥ 6 mil polyethylene sheeting, lapped 6-12 in., or ≥ 1 in. extruded polystyrene insulation with taped joints.^{4, 5, 6}
- 1.4 Capillary break at all crawlspace floors using ≥ 6 mil polyethylene sheeting, lapped 6-12 in., & installed using one of the following:^{4, 5, 6}
 - 1.4.1 Placed beneath a concrete slab; OR,
 - 1.4.2 Lapped up each wall or pier and fastened with furring strips or equivalent; OR,
 - 1.4.3 Secured in the ground at the perimeter using stakes.
- 1.5 Exterior surface of below-grade walls of basements & unvented crawlspaces finished as follows:
 - a) For poured concrete, masonry, & insulated concrete forms, finish with damp-proofing coating.⁷
 - b) For wood framed walls, finish with polyethylene and adhesive or other equivalent waterproofing.
- 1.6 Class 1 vapor retarder not installed on interior side of air permeable insulation in exterior below-grade walls.⁸
- 1.7 Sump pit cover mechanically attached with full gasket seal or equivalent.
- 1.8 Drain tile installed at basement and crawlspace walls, with the top of the drain tile pipe below the bottom of the concrete slab or crawlspace floor. Drain tile surrounded with ≥ 6 in. of $\frac{1}{2}$ to $\frac{3}{4}$ in. washed or clean gravel and with gravel layer fully wrapped with fabric cloth. Drain tile level or sloped to discharge to outside grade (daylight) or to a sump pit with a pump. If drain tile is on interior side of footing, then channel provided through footing to exterior side.⁹

2. Water-Managed Wall Assembly

- 2.1 Flashing at bottom of exterior walls, with weep holes included for anchored stone / masonry veneer or stucco cladding or equivalent drainage system.¹⁰
- 2.2 Fully sealed continuous drainage plane behind exterior cladding that laps over flashing in Item 2.1 and fully sealed at all penetrations. Additional bond-break drainage plane layer provided behind all adhered stone / masonry veneer or stucco cladding.^{10, 11}
- 2.3 Window and door openings fully flashed.¹²

3. Water-Managed Roof Assembly

- 3.1 Step and kick-out flashing at all roof-wall intersections, extending ≥ 4 " on wall surface above roof deck and integrated shingle-style with drainage plane above, boot / collar flashing at all roof penetrations.¹³
- 3.2 For homes that don't have a slab-on-grade foundation and do have expansive or collapsible soils, gutters & downspouts provided that empty to lateral piping that discharges water on sloping final grade ≥ 5 ft. from foundation, or to underground catchment system not connected to the foundation drain system that discharges water ≥ 10 ft. from foundation. Alternatives & exemptions in Footnote.^{4, 14, 15}
- 3.3 Self-adhering polymer-modified bituminous membrane at all valleys & roof deck penetrations.^{4, 16}
- 3.4 In 2009 IECC Climate Zones 5 & higher, self-adhering polymer-modified bituminous membrane over sheathing at eaves from the edge of the roof line to > 2 ft. up roof deck from the interior plane of the exterior wall.^{4, 16}

4. Water-Managed Building Materials

- 4.1 Wall-to-wall carpet not installed within 2.5 ft. of toilets, tubs, and showers.
- 4.2 Cement board or equivalent moisture-resistant backing material installed on all walls behind tub and shower enclosures composed of tile or panel assemblies with caulked joints. Paper-faced backerboard shall not be used.¹⁷
- 4.3 In Warm-Humid climates, Class 1 vapor retarders not installed on the interior side of air permeable insulation in above-grade walls, except at shower and tub walls.⁸
- 4.4 Building materials with visible signs of water damage or mold not installed or allowed to remain.¹⁸
- 4.5 Framing members & insulation products having high moisture content not enclosed (e.g., with drywall).¹⁹
- 4.6 For each condensate-producing HVAC component, corrosion-resistant drain pan (e.g., galvanized steel, plastic) included that drains to a conspicuous point of disposal in case of blockage. Backflow prevention valve included if connected to a shared drainage system.

Footnotes:

1. These requirements are designed to improve moisture control in homes. However, these features alone cannot prevent all moisture problems. For example, leaky pipes or overflowing baths can lead to moisture issues and negatively impact the performance of the home.
2. The term "Rater" refers to the person(s) completing the third-party verification required for certification. The person(s) shall: a) be a Certified Rater or Approved Inspector, as defined by ANSI / RESNET / ICC Standard 301, or an equivalent designation as determined by a Home

QA Workbook completion: Water Management Requirements

- Site grading
- WRBs
- Foundation details
- Vapor retarder
location / material



On-Site Verification: Framing

- MF % typically higher than SF
- Check w/ Phius Certified Consultant for assumed %
- Advanced framing not required if continuous insulation



Photos courtesy of A. Lisanti Integral Building & Design

8 Framing inspection: Framing matches architectural plans. If not, please describe in notes section below.

Rater Notes:

On-Site Verification: Air Barrier

- Contiguous
- Focus on critical transitions



Photos courtesy of A. Lisanti Integral Building & Design

On-Site Verification: Insulation

- Verify type, quantity and grade
- Photo documentation- show context



Photos courtesy of A. Lisanti Integral Building & Design

On-Site Verification: Insulation

- Verify type, quantity and grade
- Photo documentation



Photos courtesy of A. Lisanti Integral Building & Design

On-Site Verification: Insulation

- Verify type, quantity and grade
 - ANSI/RESNET/ICC Std 301-2019 Appendix A
- Photo documentation
- ESR Reports for unlabeled insulation material



Photos courtesy of A. Lisanti Integral Building & Design

On-Site Verification: Insulation

- AGW inspection – 301-2019 Appendix A
- GI cavity (or GII w/ continuous) Density measurement possibly necessary for blown assemblies



Photos courtesy of A. Lisanti Integral Building & Design

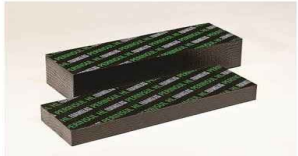
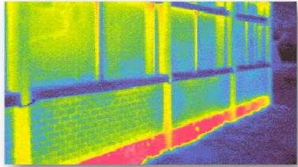
On-Site Verification: Building Envelope

Exemption from Grade I insulation install for “blind” installed assemblies if the nominal R-value is at least 50% greater than the ZERH reference home (2012 IECC).

On-Site Verification: Thermal Bridging Mitigation

Perinsul HL – Eliminating Thermal Bridging

FRAMGLAS
Building



Photos courtesy of A. Lisanti Integral Building & Design

On-Site Verification: Mid-point blower door test

- Testing phases
 - Post air barrier ; pre-windows/doors
 - Required for Phius CORE Prescriptive 2021
 - Post windows/doors; pre-cavity insulation
 - Compartmentalization
 - Depends on demising wall construction
 - May have to wait until post-drywall

On-Site Verification: Mechanical system inspection

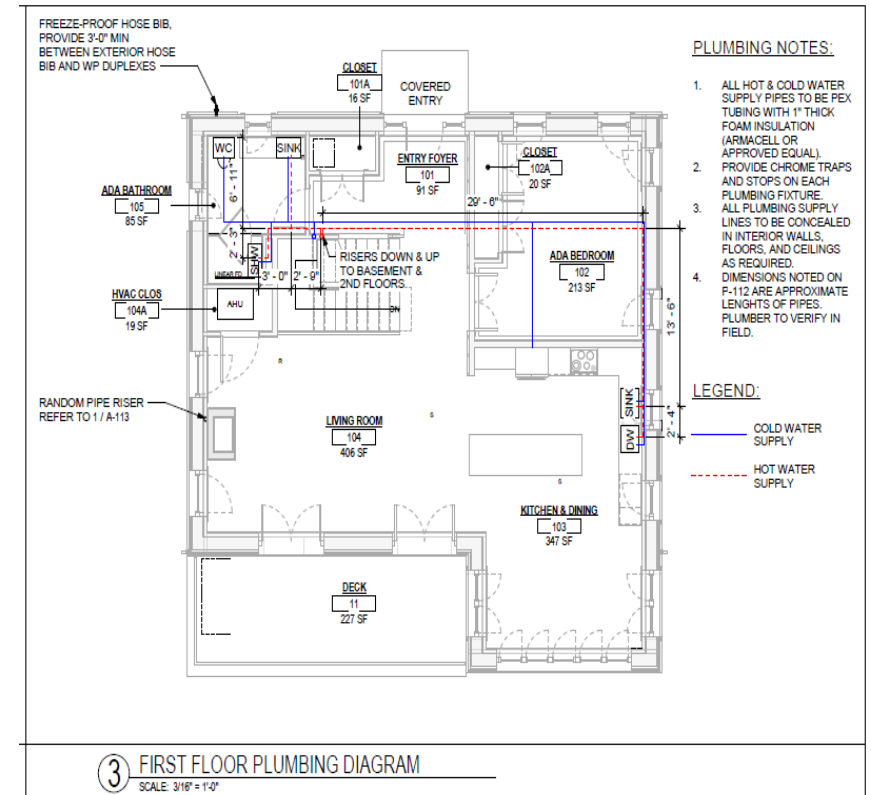
- Identifying system type/make/model #
 - Must compare to plans/specs
- Report discrepancies/variations to Phius Certified Consultant
 - Potential large impact on WUFI model!



Photos courtesy of A. Lisanti Integral Building & Design

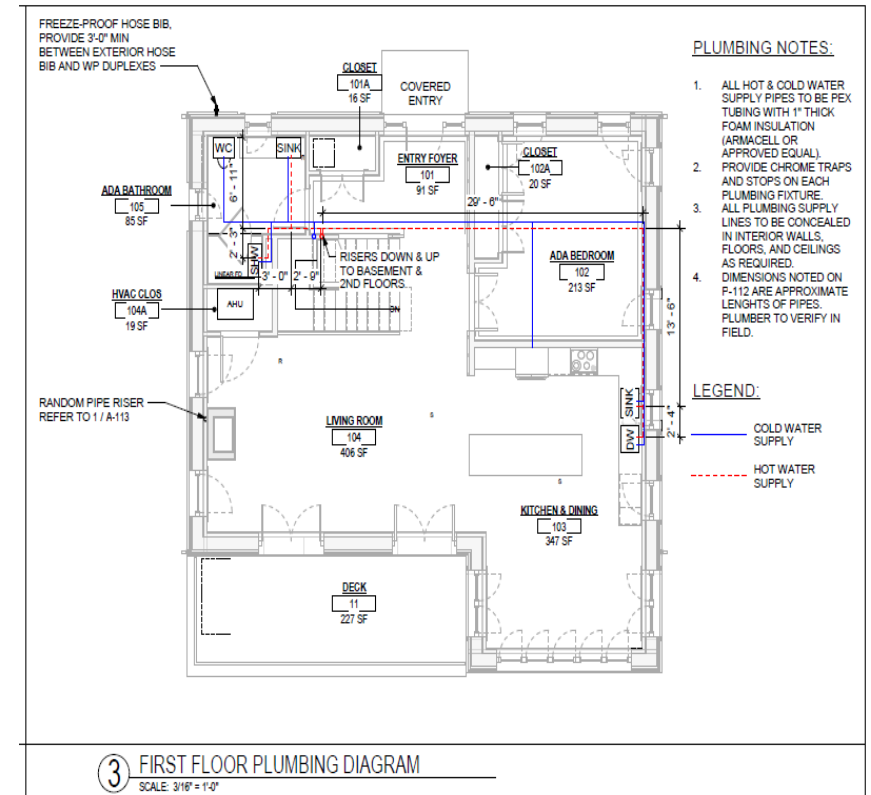
On-Site Verification: Plumbing plan review

- Pipe lengths/dimensions
 - Pipe insulation
 - Volume
- DOE ZERH/Water Sense Efficient
Hot Water Distribution
- Pumps/recirculation systems



On-Site Verification: Plumbing plan review

- DOE ZERH/Water Sense Efficient Hot Water Distribution
 - 0.5 gallon limit WH-Farthest fixture
 - 0.6 gallon draw w/ 10 deg F temp. rise
- OR,
- High EF/UEF Energy Factor for WH
 - Water Sense Shower heads & Faucets
 - 1.2 gallon limit WH – farthest fixture
 - 1.4 gallon draw w/ 10 deg F temp. rise



Photos courtesy of A. Lisanti Integral Building & Design

Combustion Devices Inside the Home

Combustion Devices are **allowed**, but

- *Not in Phius CORE Prescriptive 2021*
- Water heaters (sealed combustion)
- Boilers/furnaces (sealed combustion)
- Fireplaces
 - Woodstoves
 - Fireplace inserts
 - Sealed combustion gas units
- Must have dedicated combustion air source from outside the envelope
- CO Detectors
- OPEN and/or UNVENTED FIREPLACES ARE PROHIBITED!



Photos courtesy of A. Lisanti Integral Building & Design

Testing

Rough-in duct testing

- Heating/cooling
 - None outside of envelope
 - 4% Total Leakage can be used @ rough to comply
 - ANSI/RESNET/ICC 301-2019 Exemptions can apply
- Ventilation
 - Duct testing not required (SF)
 - Recommended on systems if possible
 - No greater than 10% max ventilation CFM leakage
- Common systems
 - Not required; recommended
 - Check w/ mechanical contractor and/or T&B firm

Testing

Duct testing

- If not performed at rough-in...
- 8% Total Leakage
 - Entire system installed
 - Applies to individual dwelling unit ducted heating/cooling systems
 - Ducts < 10' linear exempt
- 4% Leakage to Outside
 - Only applies if doing a HERS Rating
 - Should be essentially 0%

Testing

- Appliances
 - Photos of name tags
- HVAC equipment
- Surrounding areas
- PV system components
- DWH Efficiency components
 - Photos of Temp. Rise test



Photos courtesy of A. Lisanti Integral Building & Design

Testing: Total system airflow

- Applies to individual dwelling unit ducted heating/cooling systems
- Must meet design +/- 15%
- Testing methods
 - Total ESP fan curves
 - Temp rise
 - Duct blaster
 - TruFlow plate
 - Powered Flow Hoods



Ventilation System Commissioning

1. Set airflow at ERV/HRV to the design value from Pre-Cert. Model (WUFI) (this is provided by the Consultant)
2. Verify filters are clean
3. Confirm total supply and exhaust flows within 10% of each other
4. Confirm Total Supply and Exhaust flows within 10% of Design Values
5. Balance individual supply and exhaust to the design values (Ex: kitchen = 35 cfm, bathrooms = 24cfm, etc..)
6. Check Bedroom pressures WRT to main body of home
7. Verify airflow can achieve 0.30 ACH - provided by the Consultant
8. Measure power input to ERV/HRV at the standard/normal airflow Consultant updates the WUFI Model with the fan efficiency, as installed (W/cfm)
9. Special procedure for Minotair Units

HVAC system commissioning

- Relies on Energy Star balancing tolerances 25% or 25 CFM
- Heating/Cooling Bedroom pressures - +/- 3Pa WRT to main body of house
- Ventilation Bedroom pressures +/-1 Pa WRT to main body of house

Ventilation Measurement

- Airflow testing at ERV/HRV – supply and exhaust within 10% of each other
- Powered Flow Hood
- Kele Airflow Station
- TEC Flow Bucket
- Testo 417 w/ accessories
- Plastic bag w/ stop watch
- Refer to ANSI/RESNET/ICC Std 380-2019 & PHIUS Guid



Acin FlowFinder mk2



Ventilation System Balancing

- Airflow testing at supply and exhaust outlets within the greater of 20% of design value or 5cfm
- NOTE: Passive Flow measuring devices are not accurate below 100 CFM
- Powered Flow Hoods are not accurate above 300- 400 CFM



Acin FlowFinder mk2



Alnor EBT731 Capture Hood

Ventilation System Balancing

- Acin Flow Finder MK2:
Measuring Range- 6 to 323 CFM with pressure compensation up to 500 CFM with calculated compensation.
- Uncertainty 3% of the reading with a minimum of 2CFM



Acin FlowFinder mk2



Alnor EBT731 Capture Hood

Ventilation & HVAC Testing

- Room pressure imbalance $\leq 3.0\text{Pa}$ when heating/cooling system is on
- $\leq 1.0\text{Pa}$ when ventilation system is on



Ventilation System

- Measure power after balancing
- User controls & service access

Ask for Help!



Lights + Appliances

- All installed appliances are Energy Star qualified (refrigerator, dishwasher, clothes washer)
- $\geq 80\%$ of lighting is Energy Star bulbs/lamps or fixtures in units
- Motors are ECM
- Photo of appliance and model/serial number tag

IAQ

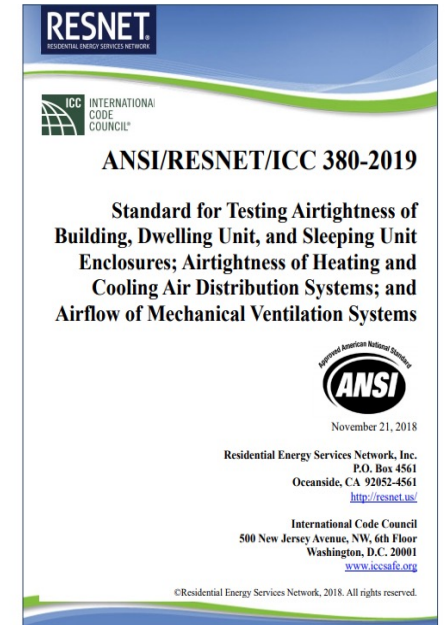
- Source control
- Filters
- Low formaldehyde pressed wood materials
- Certified low-VOC or no-VOC paints and other interior finishes
- CRI Green Label Plus carpet, pad, adhesives
- Required radon resistant features in EPA zone 1

Renewable Energy Ready

- PV Ready Checklist completed by project team and/or builder. Signed by Rater & Builder
- Lots of caveats and exemptions to some/all of both checklists. See guidance in DOE ZERH documentation.

Air Tightness Testing: Testing Procedure

- Refer to Section 3.8 in the Guidebook
- The blower door testing should be computer-controlled using automated testing software (such as “Tectite” or Autotest from The Energy Conservatory or “Fantestic” from Retrotec).
- Can tape non-assembly threatening components for performance limit; untaped for model

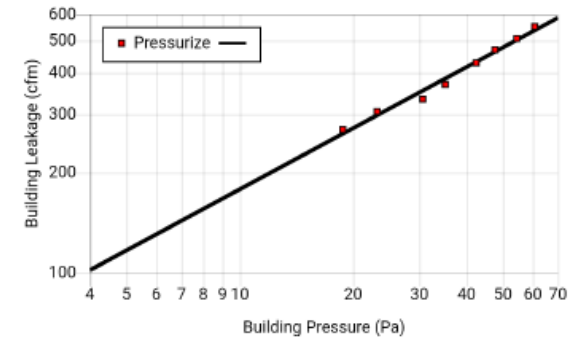


Air Tightness Testing: Testing Procedure



Measured Leakage: 0.04 CFM50/ft² (Env. Area)
Leakage Target: 0.05 CFM50/ft² (Env. Area)
Compliance with Leakage Target: Pass

Test ID: Zone 2 Prelim - Pres. Taped
Purpose of Test: NY IECC 15 Env. Leakage
Measured CFM50: 477.1 (+/- 4.0%) Effective Leakage Area: 28.9 in²
Building Volume: 0.0 ft³ Enclosure Surface Area: 10,640.0 ft²
Flow Coefficient (C): 43.6 (+/- 29.0%) Exponent (n): 0.611 (+/- 0.080)
Correlation Coefficient: 0.99149
Test Standard: ASTM E779 (single mode) Test Mode: Pressurize
Test Characteristics: Pre Indoor Temp: 72 °F Post Indoor Temp: 72 °F
Pre Outdoor Temp: 75 °F Post Outdoor Temp: 75 °F
Altitude: 1,108.0 ft Time Average Period: 10 seconds
Test Date and Time: 2020-06-19 12:01:08



Project Submission







After Completion of all Field Visits and testing:

- Registered HERS Rating Model (REM/Rate) or, Building File Report from Ekotrope
- Home Energy Rating Certificate
- Program Checklists (Energy Star, IAP, DOE ZERH)
- Program Certificates
- Air Balancing Reports
- Photos
- IR Images
- Test Reports
- QA Workbook

Project Submission

After Completion of all Field Visits and testing:

- All files uploaded to project Dropbox Folder
- Shared by Certification Team with Rater
- Folder #4 “*Phius On-Site Verification*”

 - QA Feedback Forms	--	8 members	...
 0. PHIUS+ QA Workbook	--	8 members	...
 1. Checklists & Reports	--	8 members	...
 2. Blower Door Testing	--	8 members	...
 3. Photos	--	8 members	...
 4. REM-Rate model & certificate	--	8 members	...

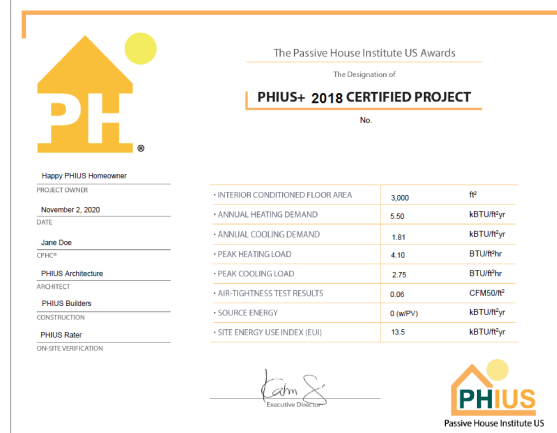
Project Submission

Before QA Review

- Document Check

After QA Review

- Phius Feedback to Rater
- After resolved Phius Certification review, then




The Passive House Institute US Awards
The Designation of
PHIUS+ 2018 CERTIFIED PROJECT
No. _____

* INTERIOR CONDITIONED FLOOR AREA	3,000	ft ²
* ANNUAL HEATING DEMAND	5.50	kBTU/ft ² yr
* ANNUAL COOLING DEMAND	1.81	kBTU/ft ² yr
* PEAK HEATING LOAD	4.10	BTU/ft ² hr
* PEAK COOLING LOAD	2.75	BTU/ft ² hr
* AIR-TIGHTNESS TEST RESULTS	0.06	CFM50/ft ²
* SOURCE ENERGY	0 (w/PV)	kBTU/ft ² yr
* SITE ENERGY USE INDEX (EUI)	13.5	kBTU/ft ² yr

Happy PHIUS Homeowner

PROJECT OWNER
November 2, 2020
DATE
Jane Doe
CPHC[®]
PHIUS Architecture
ARCHITECT
PHIUS Builders
CONSTRUCTION
PHIUS Rater
ON-SITE VERIFICATION

John S.
Executive Director



Passive House Institute US





Phius Certified Rater

On-Site Verification Training

QUESTIONS?

Thank you For Attending
tony@integralbuilding.com or; qa@phius.org