EPA United States Environmental Protection Agency

U.S. DEPARTMENT OF ENERGY CHALLENGE HOME

Zero Energy Ready Home Technical Solutions:

Indoor Air Quality & Ventilation Best Practices



2014 RESNET Conference

*-Visit **booth 415** for more info on Indoor airPLUS*

February 25, 2014

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Indoor Air Quality (IAQ)

Contents

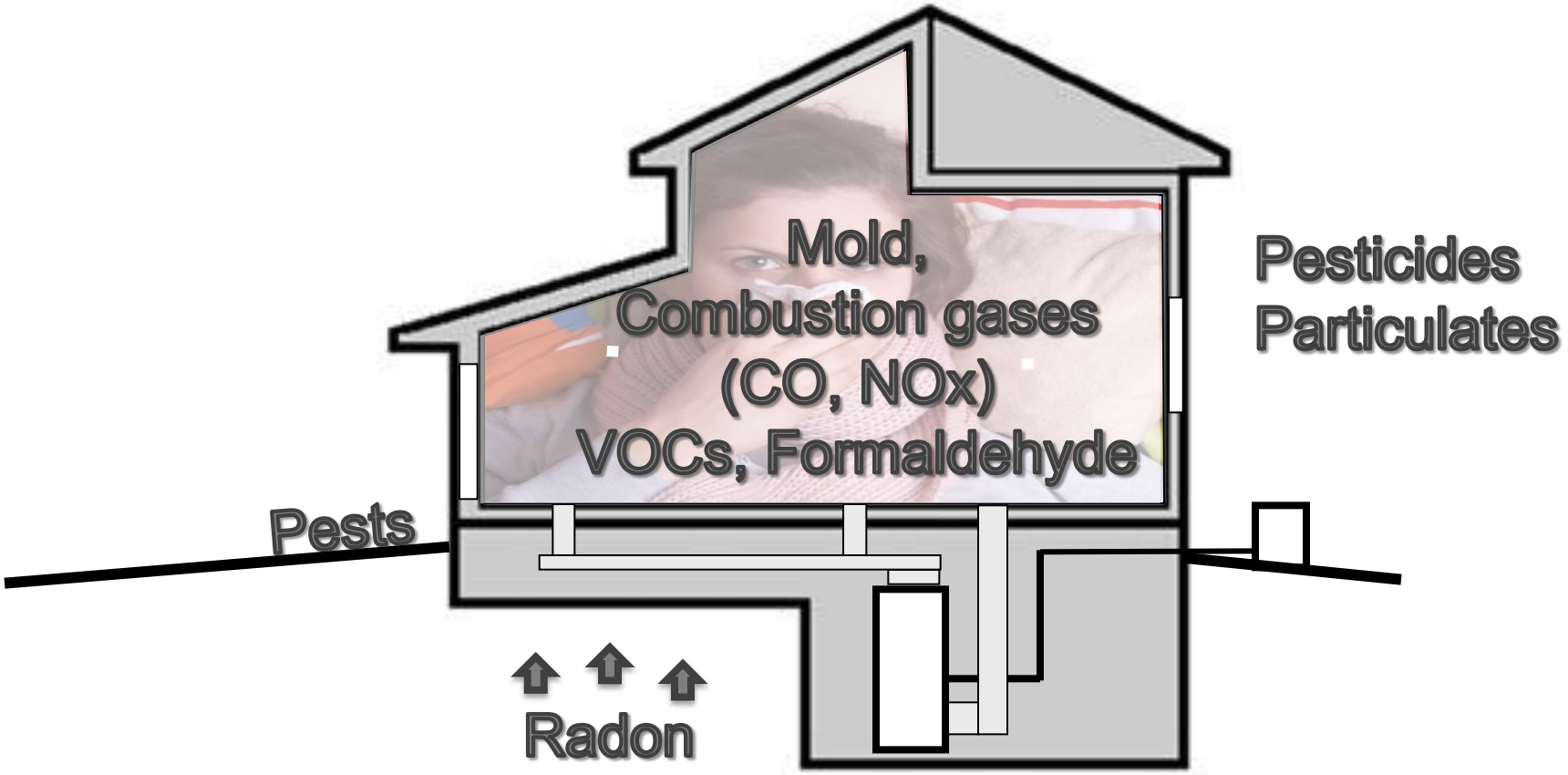
- **Indoor airPLUS Basics**
- **How to Build and Verify Indoor airPLUS Homes**
  - **Specific changes in Revision 2**
  - **Impacts on HVAC design and ventilation**
- **Resources and Partnership**

Indoor airPLUS & ENERGY STAR

Indoor airPLUS is an EPA label that adds additional health protections to your **ENERGY STAR** value proposition

Reduce Health Risks

More than 25 million people, including 7.1 million children, have asthma and there is a 20-50% increased risk of asthma in damp houses.



Reducing Health Risks

1. Source Control

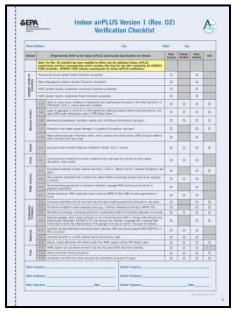
(eliminate or manage)

2. Ventilation

(dilution)

3. Filtration

Indoor airPLUS



Pest Barriers

Moisture Control

Radon Control

Materials

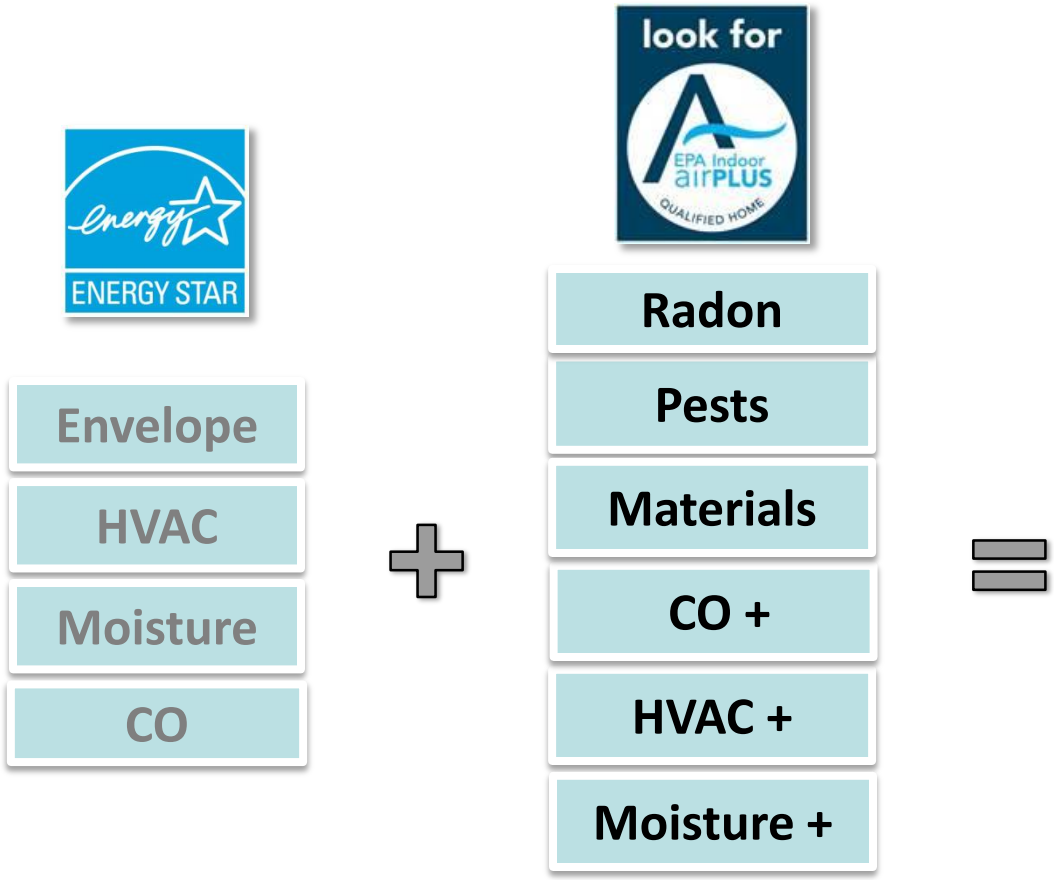
Ventilation & Filtration

Combustion Safety

look for

Indoor Air Quality (IAQ)

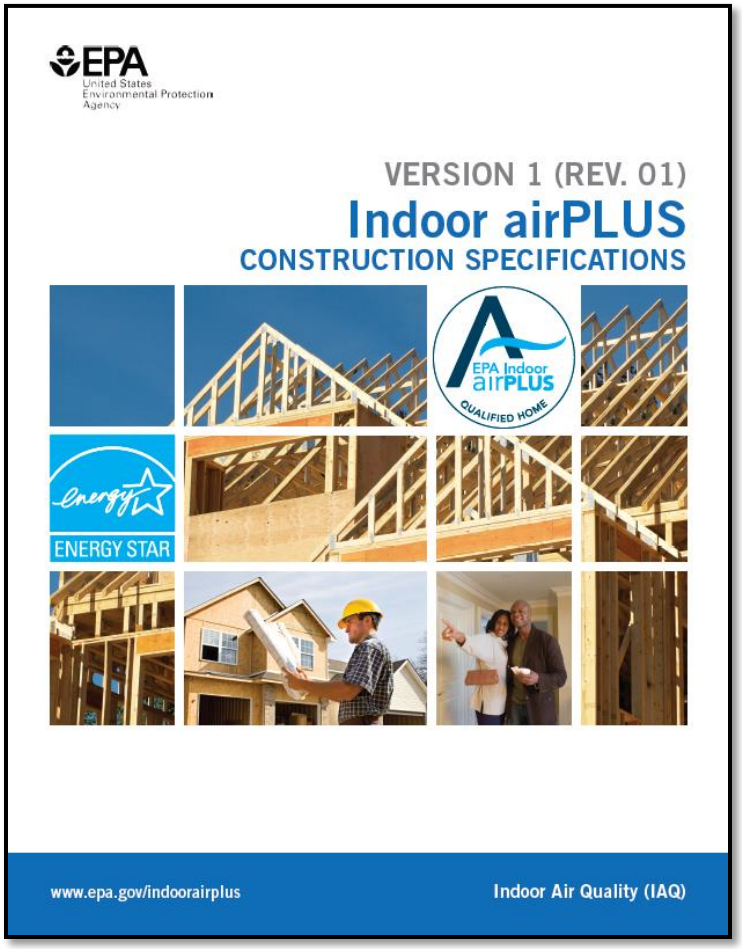
Indoor airPLUS & ENERGY STAR



ENERGY STAR + Indoor airPLUS

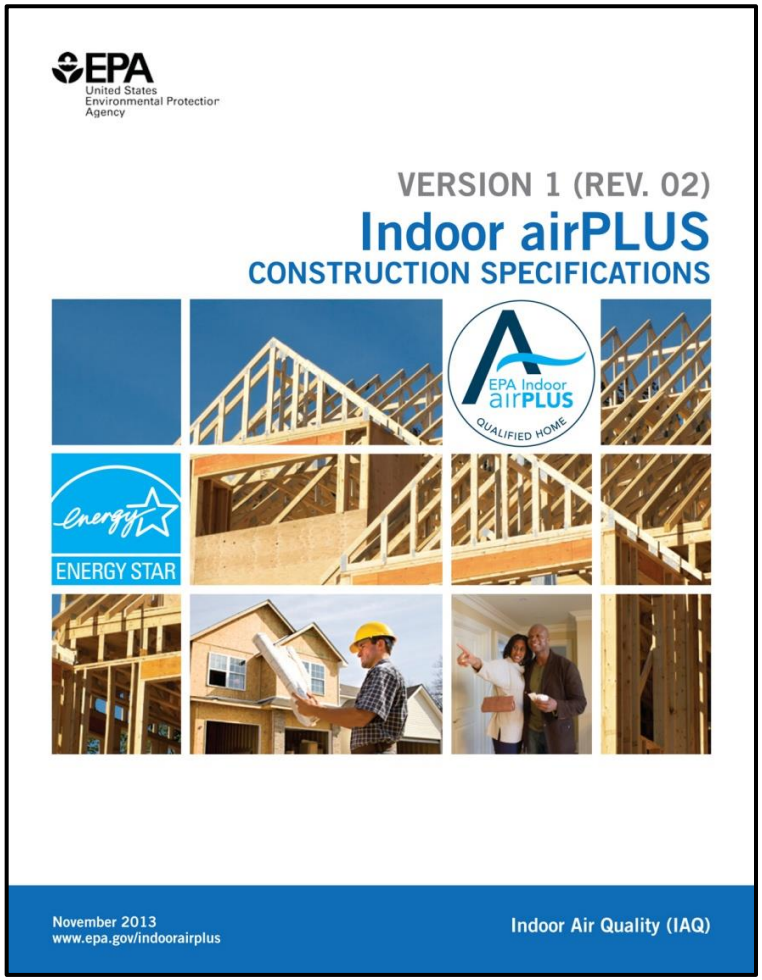
- Both programs are based on building science principles that use a systems approach to improve home performance issues.
- Both programs require completion of verification checklists by a certified Home Energy Rater.
- Visual inspection items can be verified during the same on-site visits by a certified Home Energy Rater.
- Reporting to EPA follows the same schedule and is completed using the same online program.
- Existing ENERGY STAR partners can now join Indoor airPLUS through their MESA accounts.

Revision 1



- Released February 2013.
- Greater alignment with ENERGY STAR Version 3.
- Simplified, clearer specifications.
- More flexibility and climate specific exemptions.

Revision 2

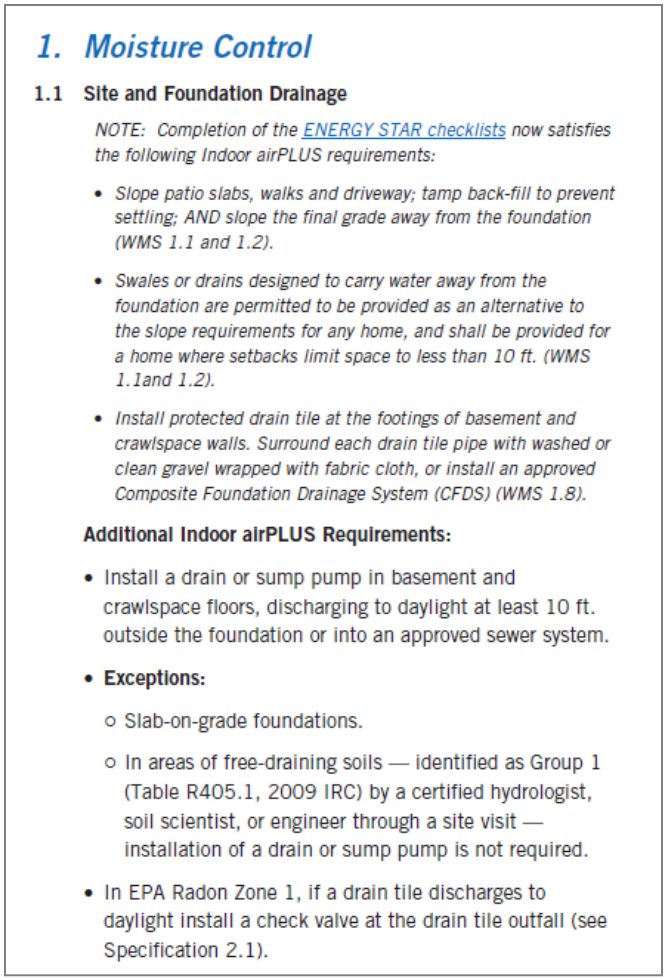


- Released November 2013
- Revised requirements for attached garages (garage fan no longer required for most homes)
- New exception from aggregate or sand requirement for slab-on-grade foundations (non-Radon Zone 1 homes only)

How to use the Construction Specifications

- **Relevant ENERGY STAR checklist items are summarized and referenced at the beginning of each measure.**
  - **Refer to the referenced ENERGY STAR Checklist for detailed requirements**

- **Additional Indoor airPLUS requirements, exceptions, and advisories are listed separately.**



1. Moisture Control

1.1 Site and Foundation Drainage

NOTE: Completion of the ENERGY STAR checklists now satisfies the following Indoor airPLUS requirements:

- *Slope patio slabs, walks and driveway; tamp back-fill to prevent settling; AND slope the final grade away from the foundation (WMS 1.1 and 1.2).*
- *Swales or drains designed to carry water away from the foundation are permitted to be provided as an alternative to the slope requirements for any home, and shall be provided for a home where setbacks limit space to less than 10 ft. (WMS 1.1and 1.2).*
- *Install protected drain tile at the footings of basement and crawlspace walls. Surround each drain tile pipe with washed or clean gravel wrapped with fabric cloth, or install an approved Composite Foundation Drainage System (CFDS) (WMS 1.8).*

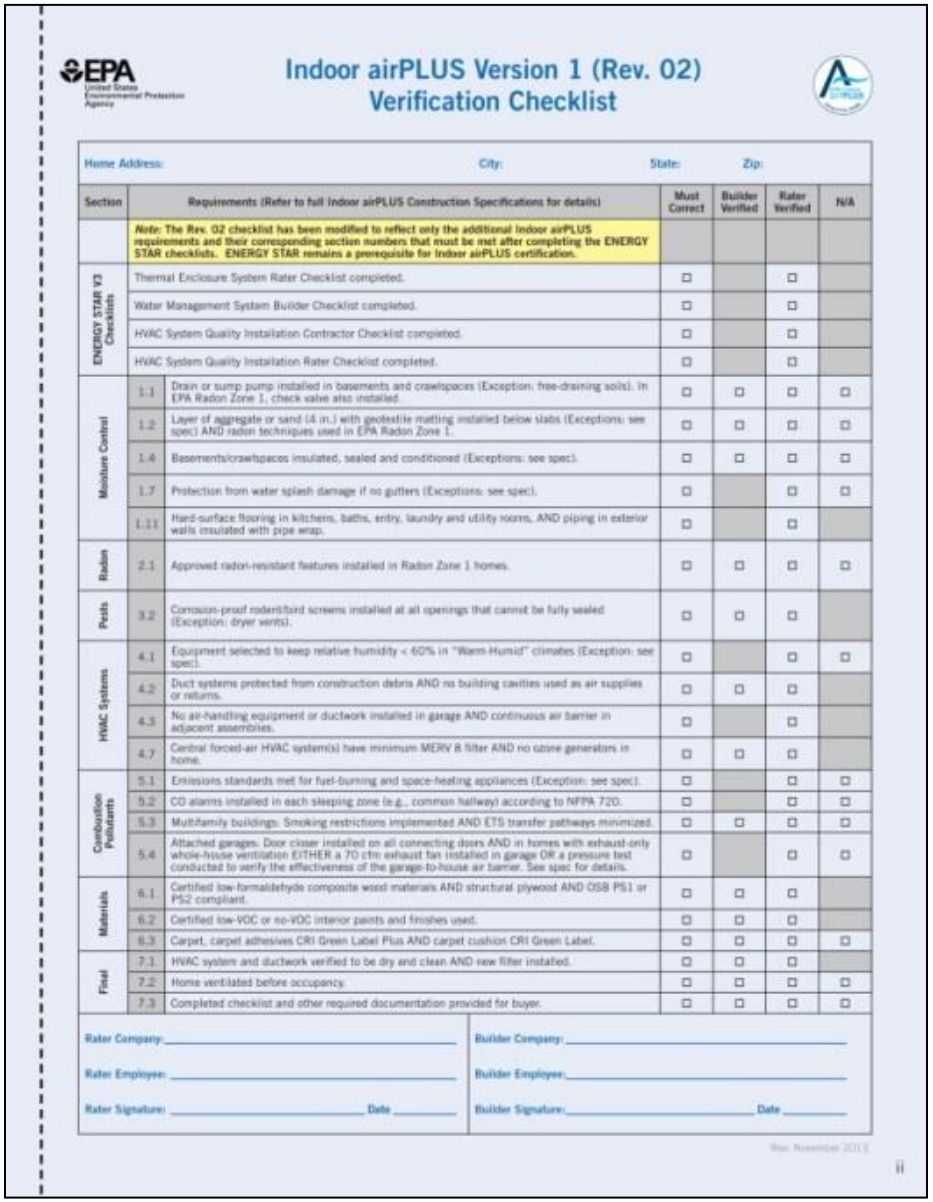
Additional Indoor airPLUS Requirements:

- Install a drain or sump pump in basement and crawlspace floors, discharging to daylight at least 10 ft. outside the foundation or into an approved sewer system.
- **Exceptions:**
  - Slab-on-grade foundations.
  - In areas of free-draining soils — identified as Group 1 (Table R405.1, 2009 IRC) by a certified hydrologist, soil scientist, or engineer through a site visit — installation of a drain or sump pump is not required.
- In EPA Radon Zone 1, if a drain tile discharges to daylight install a check valve at the drain tile outfall (see Specification 2.1).

Simplified Verification Checklist

Seven sections:

1. Moisture Control
2. Radon
3. Pests
4. HVAC Systems
5. Combustion Pollutants
6. Materials
7. Home Commissioning



EPA United States Environmental Protection Agency

Indoor airPLUS Version 1 (Rev. 02) Verification Checklist

Home Address: City: State: Zip:

Section		Requirements (Refer to full Indoor airPLUS Construction Specifications for details)	Must Correct	Builder Verified	Rater Verified	N/A
		Note: The Rev. 02 checklist has been modified to reflect only the additional Indoor airPLUS requirements and their corresponding section numbers that must be met after completing the ENERGY STAR checklists. ENERGY STAR remains a prerequisite for Indoor airPLUS certification.				
ENERGY STAR V3 Checklists		Thermal Enclosure System Rater Checklist completed.	☐		☐	
		Water Management System Builder Checklist completed.	☐		☐	
		HVAC System Quality Installation Contractor Checklist completed.	☐		☐	
		HVAC System Quality Installation Rater Checklist completed.	☐		☐	
Moisture Control	1.1	Drain or sump pump installed in basements and crawlspaces (Exception: free-draining soils). In EPA Radon Zone 1, check valve also installed.	☐	☐	☐	☐
	1.2	Layer of aggregate or sand (4 in.) with geotextile matting installed below slabs (Exceptions: see spec) AND radon techniques used in EPA Radon Zone 1.	☐	☐	☐	☐
	1.4	Basements/crawlspaces insulated, sealed and conditioned (Exceptions: see spec).	☐	☐	☐	☐
	1.7	Protection from water splash damage if no gutters (Exceptions: see spec).	☐		☐	☐
	1.11	Hard-surface flooring in kitchens, baths, entry, laundry and utility rooms, AND piping in exterior walls insulated with pipe wrap.	☐		☐	
Radon	2.1	Approved radon-resistant features installed in Radon Zone 1 homes.	☐	☐	☐	☐
Pests	3.2	Corrosion-proof roderit/bird screens installed at all openings that cannot be fully sealed (Exception: dryer vents).	☐	☐	☐	
HVAC Systems	4.1	Equipment selected to keep relative humidity < 60% in "Warm-Humid" climates (Exception: see spec).	☐		☐	☐
	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 AND continuous air barrier in adjacent assemblies.	☐		☐	
	4.7	Central forced-air HVAC system(s) have minimum MERV 8 filter AND no ozone generators in home.	☐	☐	☐	
Combustion Pollutants	5.1	Emissions standards met for fuel-burning and space-heating appliances (Exception: see spec).	☐		☐	☐
	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.	☐	☐	☐	☐
	5.4	Attached garages: Door closer installed on all connecting doors AND in homes with exhaust-only whole-house ventilation EITHER a 70 cfm exhaust fan installed in garage OR a pressure test conducted to verify the effectiveness of the garage-to-house air barrier. See spec for details.	☐		☐	☐
Materials	6.1	Certified low-formaldehyde composite wood materials AND structural plywood AND OSB PS1 or PS2 compliant.	☐	☐	☐	
	6.2	Certified low-VOC or no-VOC interior paints and finishes used.	☐	☐	☐	
	6.3	Carpet, carpet adhesives CRI Green Label Plus AND carpet cushion CRI Green Label.	☐	☐	☐	☐
Final	7.1	HVAC system and ductwork verified to be dry and clean AND new filter installed.	☐	☐	☐	
	7.2	Home ventilated before occupancy.	☐	☐	☐	☐
	7.3	Completed checklist and other required documentation provided for buyer.	☐	☐	☐	☐

Rater Company: Builder Company:

Rater Employee: Builder Employee:

Rater Signature: Date Builder Signature: Date

Rev. November 2013

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How to Complete the Verification Checklist

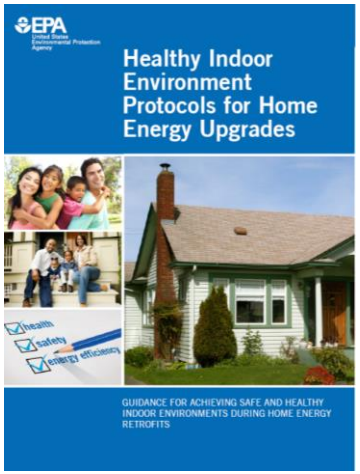
- All ENERGY STAR for Homes Version 3 checklists must be successfully completed and reported to achieve Indoor airPLUS qualification.
- Check one box per line.
- Check “N/A” for specifications that do not apply for specific conditions (e.g., climate) according to the exceptions described.
- Check either “Builder Verified” or “Rater Verified” for all other items.

Home Address:		City:	State:	Zip:	
Section	**Requirements (Refer to full Indoor airPLUS Construction Specifications for details)**	**Must Correct**	**Builder Verified**	**Rater Verified**	**N/A**
	***Note:* The Rev. 02 checklist has been modified to reflect only the additional Indoor airPLUS requirements and their corresponding section numbers that must be met after completing the ENERGY STAR checklists. ENERGY STAR remains a prerequisite for Indoor airPLUS certification.**				
ENERGY STAR V3 Checklists	Thermal Enclosure System Rater Checklist completed.	☐		☐	
	Water Management System Builder Checklist completed.	☐		☐	
	HVAC System Quality Installation Contractor Checklist completed.	☐		☐	
	HVAC System Quality Installation Rater Checklist completed.	☐		☐	

What About Existing Homes?

- Indoor airPLUS not designed for existing homes.
- Under certain conditions, (e.g., gut rehabs) if ENERGY STAR requirements and Indoor airPLUS requirements are met.
- For most renovation and energy upgrade work, see EPA's Healthy Indoor Environment Protocols for Home Energy Upgrades.

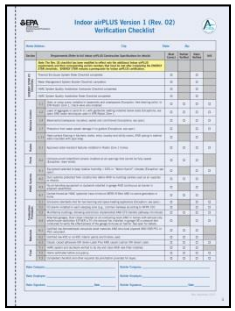
http://www.epa.gov/iaq/homes/retrofits.html



How to Build and Verify Indoor airPLUS Homes

Recent Revisions and Ventilation Considerations

Indoor airPLUS



Pest Barriers

Moisture Control

Radon Control

Materials

Ventilation & Filtration

Combustion Safety

look for

Indoor Air Quality (IAQ)

1. Moisture Control

- Moisture is a leading cause of health, comfort and durability concerns in homes.
- 19% of U.S. households have at least one person with Asthma.
- There is a 20-50% increased risk of asthma in damp houses.
- The economic cost of asthma amounts to more than $56 billion annually.
- Mold grows where there is moisture.
- Molds produce allergens, irritants, and in some cases, potentially toxic substances.

1.1 Site and Foundation Drainage

- *Slope hard surfaces and final grade away from the foundation.*
- *Install drain tile at the footings of basement and crawlspace walls.*

- **Install a drain or sump in basement and crawlspace floors.**

**Exceptions: Slab-on-grade and areas with free draining soils*

1.1 Site and Foundation Drainage

Verification

- Can be builder or Rater verified.
- **Visually verify during pre-slab** inspection the drain or sump pump's discharge to daylight (including distance from the foundation) or connection to the sewer.
- In Radon Zone 1, visually verify check-valve installed.
- Review documentation of free-draining soils when the exception is used.

Section		Requirements (Refer to full Indoor airPLUS Construction Specifications for details)	Must Correct	Builder Verified	Rater Verified	N/A
Moisture Control	1.1	Drain or sump pump installed in basements and crawlspaces (Exception: free-draining soils). In EPA Radon Zone 1, check valve also installed.	☐	■	☐	☐
	1.2	Layer of aggregate or sand (4 in.) with geotextile matting installed below slabs (Exceptions: see spec) AND radon techniques used in EPA Radon Zone 1.	☐	☐	☐	☐
	1.4	Basements/crawlspaces insulated, sealed and conditioned (Exceptions: see spec).	☐	☐	☐	☐
	1.7	Protection from water splash damage if no gutters (Exceptions: see spec).	☐		☐	☐
	1.11	Hard-surface flooring in kitchens, baths, entry, laundry and utility rooms, AND piping in exterior walls insulated with pipe wrap.	☐		☐	

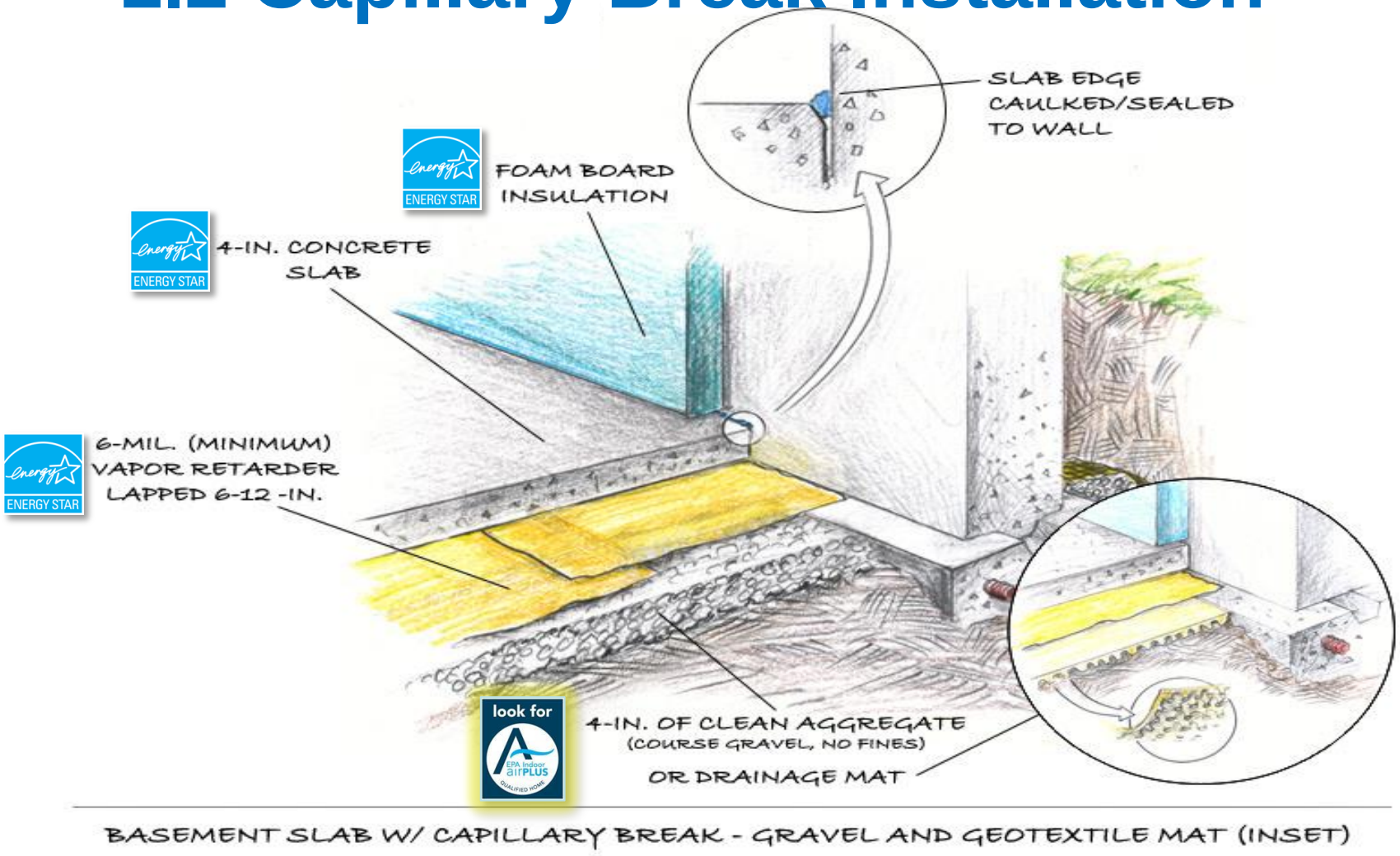
1.2 Capillary Break Installation

- *Install polyethylene sheeting or extruded polystyrene beneath concrete slabs.*
- *Install a capillary break at all crawlspace floors using polyethylene sheeting.*

- **Under the polyethylene sheeting or extruded polystyrene (XPS) insulation:**
  - **Install a 4 in. layer of aggregate; OR**
  - **A uniform layer of sand, overlain with a layer of geotextile drainage matting.**

New exception: Slab-on-grade foundations (only in Radon zones 2 & 3)

1.2 Capillary Break Installation



BASEMENT SLAB W/ CAPILLARY BREAK - GRAVEL AND GEOTEXTILE MAT (INSET)

1.2 Capillary Break Installation

Verification

- Can be builder or Rater verified.
- **Visually verify during pre-slab inspection** the capillary break is properly installed.
- In Radon Zone 1: Visually verify polyethylene sheeting has been overlapped 6 – 12 in. and the ENERGY STAR staking method for crawlspaces has not been used.

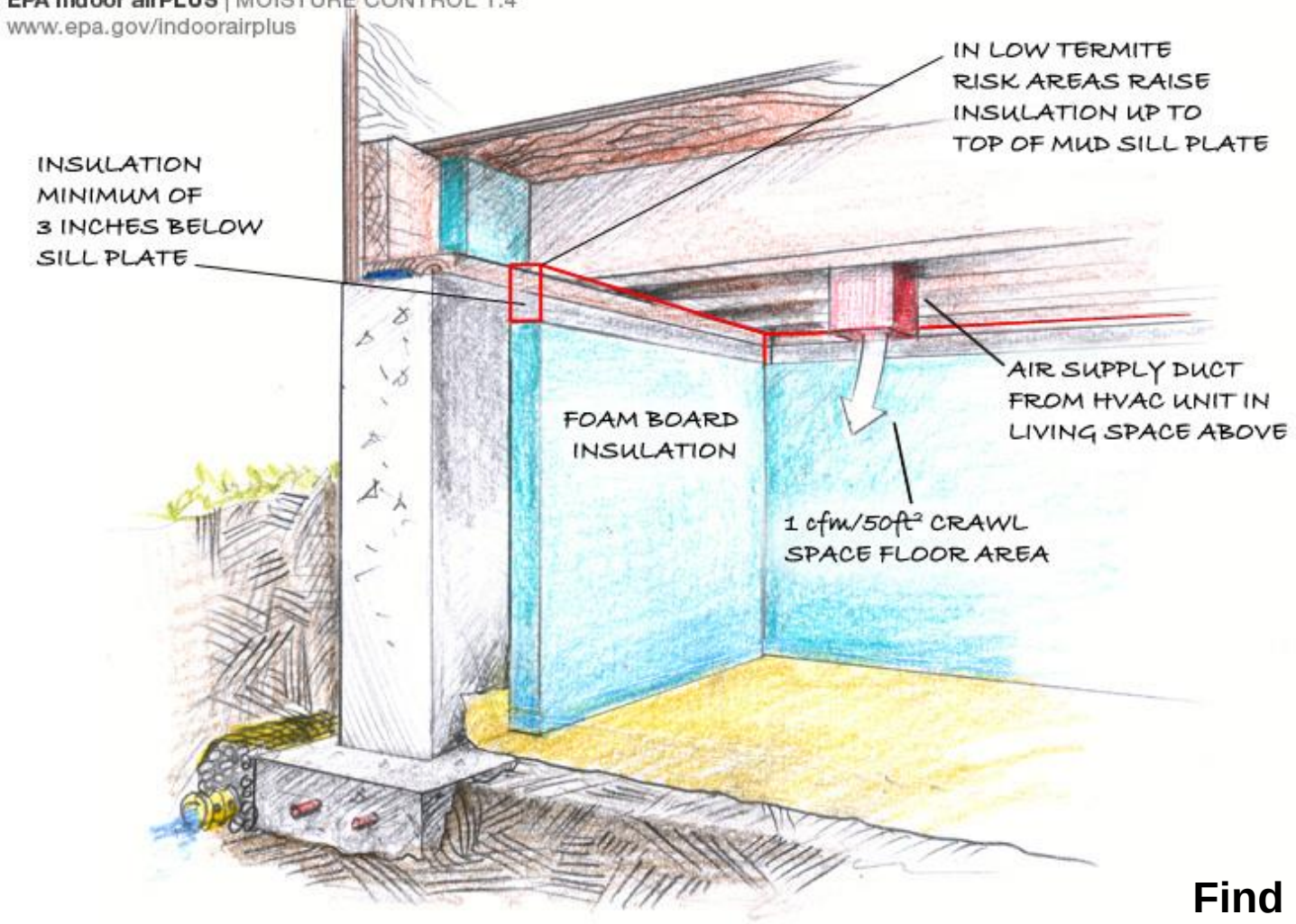
Section		Requirements (Refer to full Indoor airPLUS Construction Specifications for details)	Must Correct	Builder Verified	Rater Verified	N/A
Moisture Control	1.1	Drain or sump pump installed in basements and crawlspaces (Exception: free-draining soils). In EPA Radon Zone 1, check valve also installed.	☐	■	☐	☐
	1.2	Layer of aggregate or sand (4 in.) with geotextile matting installed below slabs (Exceptions: see spec) AND radon techniques used in EPA Radon Zone 1.	☐	☐	■	☐
	1.4	Basements/crawlspaces insulated, sealed and conditioned (Exceptions: see spec).	☐	☐	☐	☐
	1.7	Protection from water splash damage if no gutters (Exceptions: see spec).	☐		☐	☐
	1.11	Hard-surface flooring in kitchens, baths, entry, laundry and utility rooms, AND piping in exterior walls insulated with pipe wrap.	☐		☐	

1.3+1.4 Below-grade Foundation Walls

- *Waterproof crawlspace and basement perimeter walls.*
- *All floors above unconditioned spaces shall be insulated.*

- **Insulate crawlspace and basement perimeter walls.**
- **Seal crawlspace and basement perimeter walls.**
- **Provide conditioned air (1cfm/50SF).**

Exceptions: Dry climates, raised pier foundations, etc. (see spec)



Find details at:
http://epa.gov/iaplus01/technical/moisture/1_4.html

CONDITIONED AIR SUPPLY TO SEALED CRAWL SPACE

1.7 Gutters, Downspouts, and Site Drainage

Verification

- Must be Rater verified.
- The Rater should **coordinate with the builder before construction to verify** what ENERGY STAR or Indoor airPLUS compliance option is being pursued.
- The Rater should **visually verify at final inspection** that the selected compliance option is properly installed (for example, that the foundation wall is extended *at least 16 in.* above final grade).

Section		Requirements (Refer to full Indoor airPLUS Construction Specifications for details)	Must Correct	Builder Verified	Rater Verified	N/A
Moisture Control	1.1	Drain or sump pump installed in basements and crawlspaces (Exception: free-draining soils). In EPA Radon Zone 1, check valve also installed.	☐	■	☐	☐
	1.2	Layer of aggregate or sand (4 in.) with geotextile matting installed below slabs (Exceptions: see spec) AND radon techniques used in EPA Radon Zone 1.	☐	■	☐	☐
	1.4	Basements/crawlspaces insulated, sealed and conditioned (Exceptions: see spec).	☐	☐	■	☐
	1.7	Protection from water splash damage if no gutters (Exceptions: see spec).	☐		☐	■
	1.11	Hard-surface flooring in kitchens, baths, entry, laundry and utility rooms, AND piping in exterior walls insulated with pipe wrap.	☐		☐	

1.11 Moisture-Resistant Materials

- *Install moisture-resistant backing material behind tub and shower enclosures.*
- *Install a corrosion-resistant drain pan.*

- **Install only water-resistant hard-surface flooring in kitchens, bathrooms, entryways, laundry areas, and utility rooms.**
- **Insulate water supply pipes in exterior walls with pipe wrap.**

1.11 Moisture Resistant-Materials

Verification

- Must be Rater verified.
- The Rater should **visually verify at the pre-drywall inspection** that all water supply lines in exterior walls are properly insulated with pipe wrap.
- The Rater should **visually verify at final inspection** that only water-resistant hard-surface flooring is installed in the required rooms.

Section		Requirements (Refer to full Indoor airPLUS Construction Specifications for details)	Must Correct	Builder Verified	Rater Verified	N/A
Moisture Control	1.1	Drain or sump pump installed in basements and crawlspaces (Exception: free-draining soils). In EPA Radon Zone 1, check valve also installed.	☐	■	☐	☐
	1.2	Layer of aggregate or sand (4 in.) with geotextile matting installed below slabs (Exceptions: see spec) AND radon techniques used in EPA Radon Zone 1.	☐	■	☐	☐
	1.4	Basements/crawlspaces insulated, sealed and conditioned (Exceptions: see spec).	☐	☐	■	☐
	1.7	Protection from water splash damage if no gutters (Exceptions: see spec).	☐		■	☐
	1.11	Hard-surface flooring in kitchens, baths, entry, laundry and utility rooms, AND piping in exterior walls insulated with pipe wrap.	☐		■	

Revision 2 Moisture Control Changes

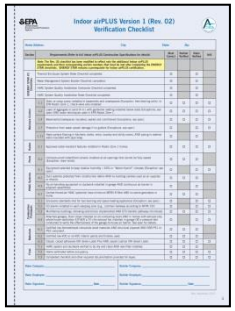
Section	Changes
1.2 Capillary Break	Clarification added: XPS may be used under slabs provided it is used in addition to the required 6 mil polyethylene sheeting. Exceptions added (non-EPA Radon Zone 1): Sand or aggregate under slab not required in areas with free-draining soils or homes with slab-on-grade foundations.

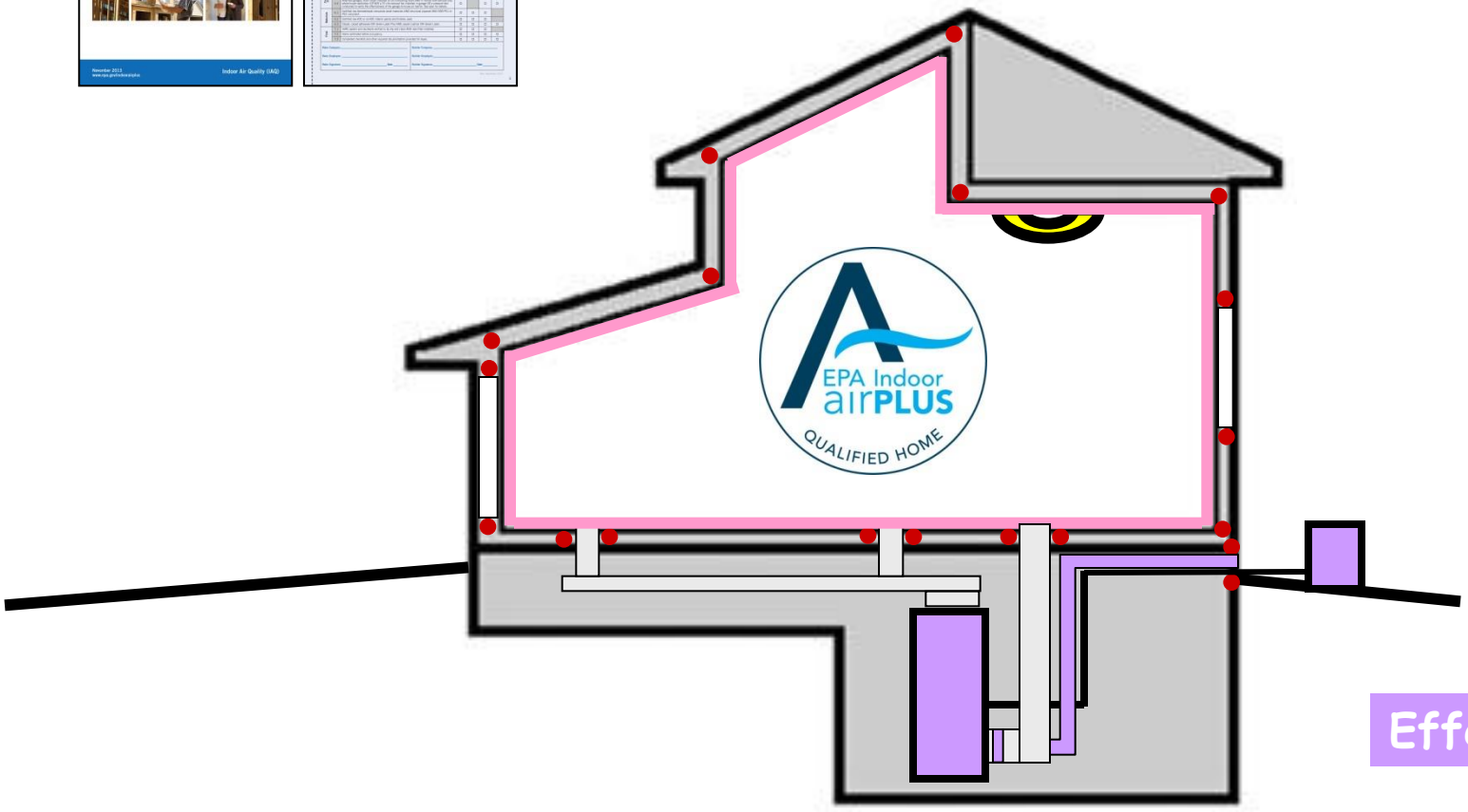
1. Moisture Control & Water Management

Benefits

- Water damage reduction
- Flood mitigation
- Structural durability
- Reduces potential for mold growth – even in places you can't see.
- Fewer maintenance issues from peeling paint and moldy grout

4. HVAC Systems





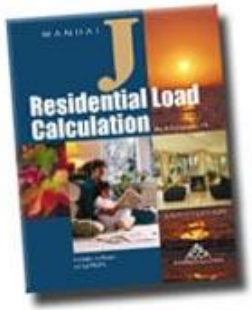
Effective HVAC

4. HVAC Systems

- Indoor relative humidity greater than 60% can encourage mold growth and attract organisms such as dust mites or other pests.
- HVAC components in wall cavities and garages can expose occupants to mold, carbon monoxide, hydrocarbons, nitrogen oxides, radon, pesticides and other contaminants.
- Ordinary residential panel filters collect less than 20 percent of the particles between 3 and 10 microns. A MERV 8 filter collects more than 70% of the particles in this range.

4.1 HVAC Sizing and Design

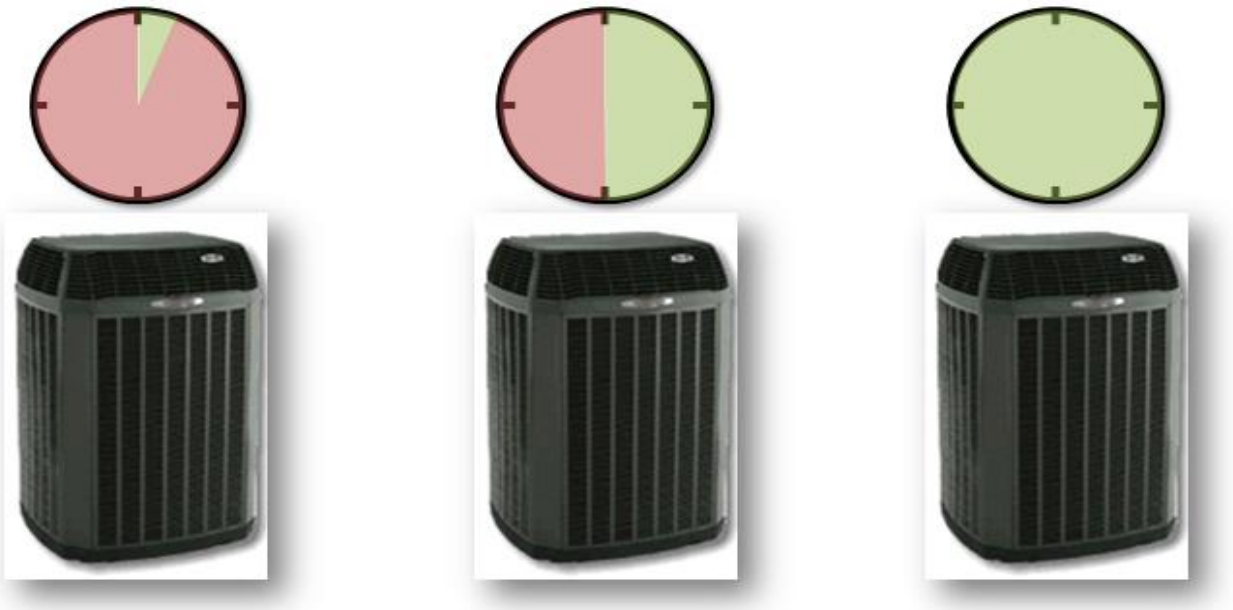
- *Properly size all heating and cooling equipment using ACCA Manual J, ASHRAE Handbooks, or equivalent software.*



- **"Warm-Humid" climates: equipment shall be installed with sufficient latent capacity to maintain indoor relative humidity (RH) at or below 60 percent.**

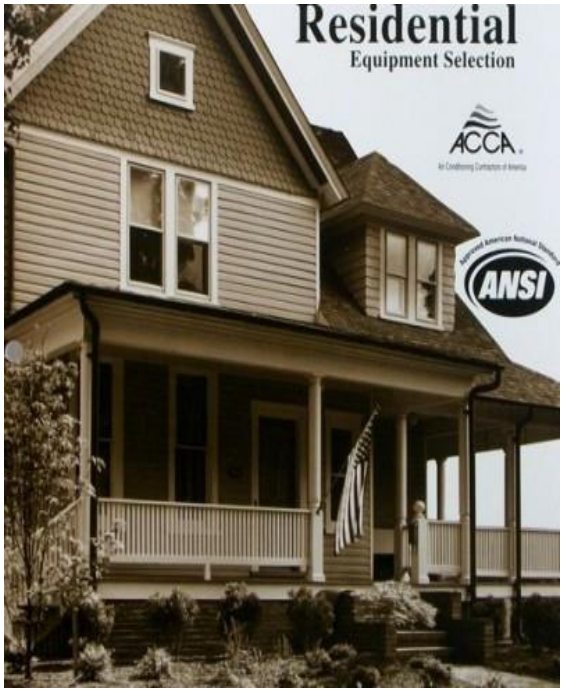
4.1 HVAC Sizing and Design

- Heating and cooling equipment generally has just two modes – on & off.
- Right sizing is key in controlling RH with HVAC systems
- The HVAC system must operate to remove moisture !



4.1 HVAC Sizing and Design

- **By following the procedures in Manual S for selecting HVAC systems you can ensure the HAVC system selected can cover the latent (moisture) load of the home.**
- **HVAC systems have a broad range of capabilities depending on fan speeds and controls.**
- **A humidistat may be used in some systems to achieve additional de-humidification.**
- **In some extreme cases a separate de-humidifier may be required to supplement moisture removal.**



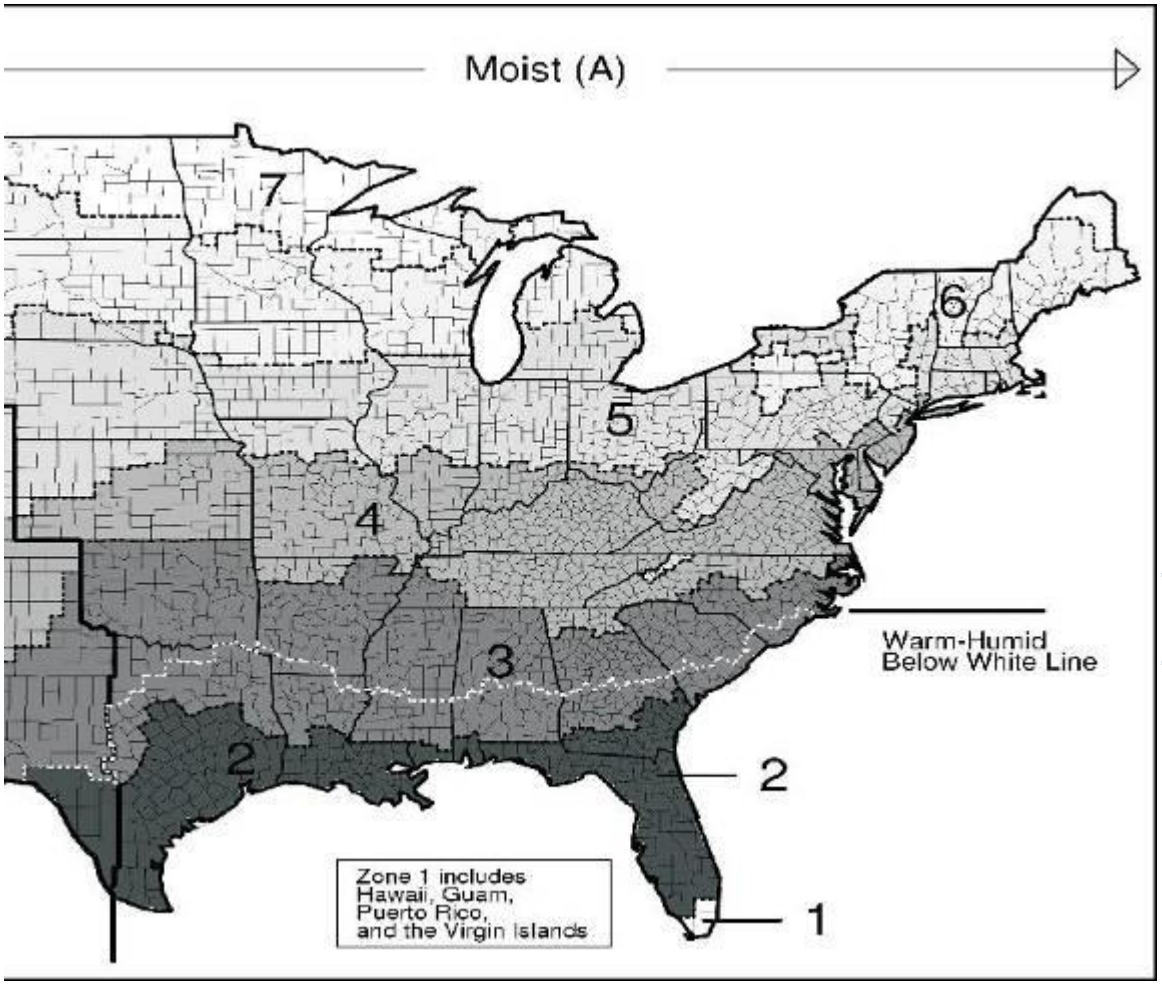
4.1 HVAC Sizing and Design

14ACX-036-230-13 - C33-36B/C-6F + EL296UH045V36B

Entering Wet Bulb Temper-ature	Total Air Volume	Outdoor Air Temperature Entering Outdoor Coil																			
		85°F					95°F					105°F					115°F				
		Total Cool Cap.	Comp Motor Input	Sensible to Total Ratio (S/T) Dry Bulb			Total Cool Cap.	Comp Motor Input	Sensible to Total Ratio (S/T) Dry Bulb			Total Cool Cap.	Comp Motor Input	Sensible to Total Ratio (S/T) Dry Bulb			Total Cool Cap.	Comp Motor Input	Sensible to Total Ratio (S/T) Dry Bulb		
	cfm	kBtuh	kW	75°F	80°F	85°F	kBtuh	kW	75°F	80°F	85°F	kBtuh	kW	75°F	80°F	85°F	kBtuh	kW	75°F	80°F	85°F
63°F	1020	33.6	1.95	0.77	0.92	1	32	2.21	0.79	0.94	1	30.2	2.51	0.81	0.97	1	28.4	2.84	0.84	0.99	1
	1210	34.8	1.95	0.81	0.97	1	33.2	2.22	0.83	0.99	1	31.4	2.52	0.86	1	1	29.8	2.85	0.89	1	1
	1370	35.6	1.96	0.85	1	1	34	2.23	0.87	1	1	32.6	2.53	0.9	1	1	30.8	2.85	0.93	1	1
67°F	1020	35.2	1.96	0.61	0.75	0.88	33.6	2.22	0.62	0.77	0.91	31.8	2.52	0.64	0.79	0.93	30	2.85	0.65	0.81	0.96
	1210	36.6	1.97	0.64	0.79	0.94	34.8	2.23	0.65	0.81	0.96	33	2.53	0.67	0.83	0.99	31	2.85	0.68	0.86	1
	1370	37.4	1.97	0.66	0.83	0.98	35.6	2.24	0.68	0.85	1	33.6	2.54	0.69	0.88	1	31.6	2.87	0.71	0.91	1
71°F	1020	36.8	1.97	0.47	0.6	0.73	35.2	2.24	0.47	0.61	0.74	33.4	2.53	0.48	0.62	0.76	31.6	2.86	0.48	0.64	0.79
	1210	38	1.98	0.48	0.63	0.77	36.4	2.24	0.49	0.64	0.79	34.6	2.55	0.49	0.65	0.81	32.6	2.87	0.5	0.67	0.84
	1370	39	1.98	0.49	0.65	0.8	37.4	2.25	0.5	0.67	0.83	35.4	2.55	0.51	0.68	0.85	33.2	2.88	0.52	0.7	0.88

- Total Design Capacity = 33.2 kBTU/h
- Sensible Design Capacity = 33.2 x 0.83 = 27.6 kBTU/h
- Latent Design Capacity = 33.2 - 27.6 = 5.6 kBTU/h

4.1 HVAC Sizing and Design



Controlled to
≤ 60% RH

4.1 HVAC Sizing and Design

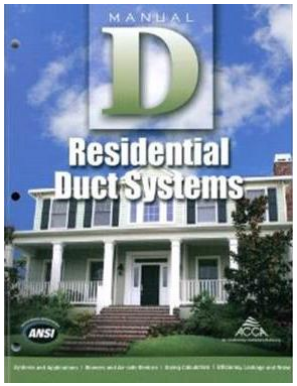
Verification

- Must be Rater verified.
- Rater should **verify documentation before the start of construction** showing the method and calculations for retaining an indoor relative humidity below 60 percent.
- Rater should **visually verify at final inspection** that the designed system has been properly installed.

Section		Requirements (Refer to full Indoor airPLUS Construction Specifications for details)	Must Correct	Builder Verified	Rater Verified	N/A
HVAC Systems	4.1	Equipment selected to keep relative humidity < 60% in "Warm-Humid" climates (Exception: see spec).	☐		■	☐
	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 AND continuous air barrier in adjacent assemblies.	☐		☐	
	4.7	Central forced-air HVAC system(s) have minimum MERV 8 filter AND no ozone generators in home.	☐	☐	☐	

4.2 Duct System Design and Installation

- *Design all duct systems according to ACCA Manual D, ASHRAE Handbooks, or equivalent software.*
- *Ensure that all duct systems are airtight and properly balanced.*



- **Do not use building cavities as part of the forced air supply or return systems.**
- **Cover duct openings throughout construction or vacuum out ducts prior to installing registers.**

4.2 Duct System Design and Installation

COVERING DUCT OPENINGS DURING CONSTRUCTION

SEALING WITH MASTIC

4.2 Duct System Design and Installation

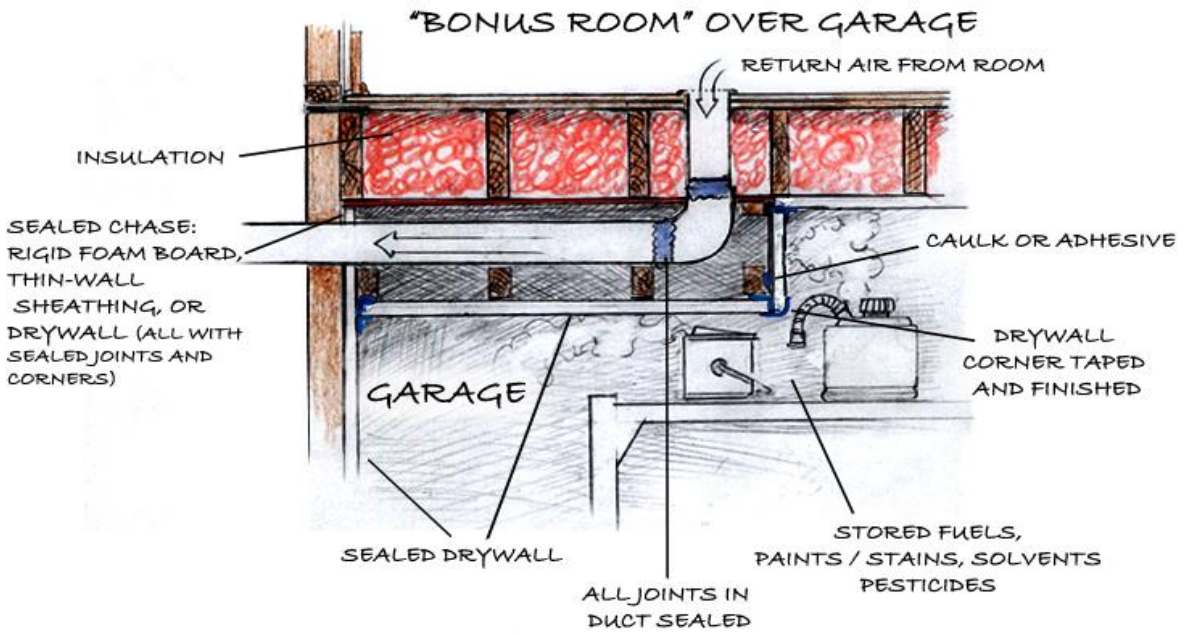
Verification

- Can be builder or Rater verified.
- **Visually verify at pre-drywall inspection** that no cavities are used as part of the forced air system.
- Verify that all duct openings were covered during construction or have been thoroughly vacuumed upon completion.

Section		Requirements (Refer to full Indoor airPLUS Construction Specifications for details)	Must Correct	Builder Verified	Rater Verified	N/A
HVAC Systems	4.1	Equipment selected to keep relative humidity < 60% in "Warm-Humid" climates (Exception: see spec).	☐		■	☐
	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 AND continuous air barrier in adjacent assemblies.	☐		☐	
	4.7	Central forced-air HVAC system(s) have minimum MERV 8 filter AND no ozone generators in home.	☐	☐	☐	

4.3 Location of Air Handler and Ducts

- **Do not locate air-handling equipment or ductwork in garages.**
- **Note: Ducts may be located in building cavities adjacent to the garage if they are separated with a continuous air barrier.**



4.3 Location of Air-Handling Equipment and Ductwork

Verification

- Must be Rater verified.
- Rater should **visually verify at pre-drywall inspection** that no air-handling equipment of ductwork has been installed in the garage and any ducts or equipment located in adjacent framing spaces has been separated from the garage space by a continuous air barrier.

Section		Requirements (Refer to full Indoor airPLUS Construction Specifications for details)	Must Correct	Builder Verified	Rater Verified	N/A
HVAC Systems	4.1	Equipment selected to keep relative humidity < 60% in "Warm-Humid" climates (Exception: see spec).	☐		■	☐
	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 AND continuous air barrier in adjacent assemblies.	☐		■	
	4.7	Central forced-air HVAC system(s) have minimum MERV 8 filter AND no ozone generators in home.	☐	☐	☐	

4.5 Mechanical Whole-House Ventilation

- *Provide mechanical whole-house ventilation meeting ASHRAE 62.2-2010.*
- *Test airflows to ensure they meet ASHRAE 62.2-2010.*

- **Advisory: Outdoor air ducts connected to the return side of an air handler should be used as supply ventilation only if the manufacturers' requirements for return air temperature are met.**

4.5 Mechanical Whole-House Ventilation

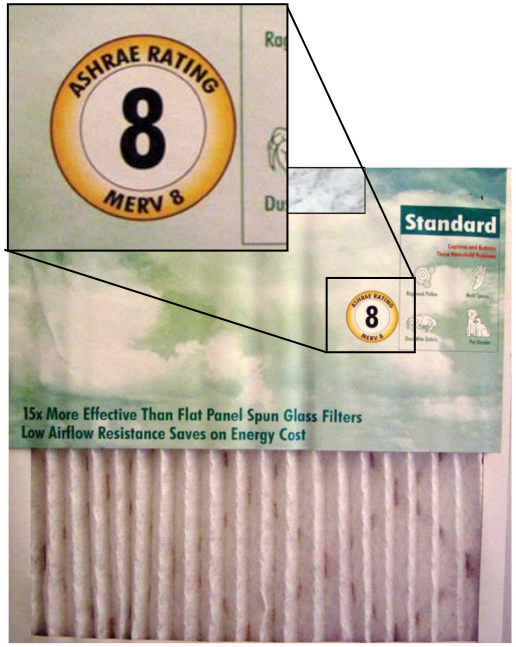
FRESH AIR DAMPER

DUCTED FRESH AIR SUPPLY

4.7 Filtration

- *Equip all filter access panels with gasket material or comparable sealing mechanism to prevent bypass air.*

- **Install only HVAC filters that are rated MERV 8 or higher.**
- **Do not install any air-cleaning equipment designed to produce ozone.**



4.7 Filtration for Central Forced-Air HVAC Systems

- **Filters come in multiple sizes.**
- **Filters are typically 1” 2” or 4” in depth.**
- **In years past, the primary purpose for filtration was to protect the HVAC system, not IAQ.**

4.7 Filtration for Central Forced-Air HVAC Systems

- **Filters have performance data that must be accounted for in the duct design.**
- **When selecting a filter try to find a filter that creates the least amount of resistance.**
- **There are multiple types of filter sizes and depths.**
- **Media filters have a much greater surface area and will cause less restriction.**

Typical Performance Data

Filter Depth	Nominal Size	Capacities (CFM)		Resistance (inches W.G.)			Pleats per Linear foot	Media Area (SQ. FT.)
		Med	High	Med	High	Final		
1"	12x24	600	1000	.18	.36	1.0	14	4.7
	16x20	650	1100	.18	.36	1.0	14	5.3
	16x25	850	1350	.18	.36	1.0	14	6.6
	20x20	850	1350	.18	.36	1.0	14	6.7
	20x25	1050	1750	.18	.36	1.0	14	8.3
	24x24	1200	2000	.18	.36	1.0	14	9.3
2"	12x24	600	1000	.14	.26	1.0	10	6.7
	16x20	650	1100	.14	.26	1.0	10	7.8
	16x25	850	1350	.14	.26	1.0	10	9.7
	20x20	850	1350	.14	.26	1.0	10	9.4
	20x25	1050	1750	.14	.26	1.0	10	11.8
	24x24	1200	2000	.14	.26	1.0	10	13.3
4"	12x24	600	1000	.12	.22	1.0	11	14.7
	16x20	650	1100	.12	.22	1.0	11	16.7
	16x25	850	1350	.12	.22	1.0	11	20.8
	20x20	850	1350	.12	.22	1.0	11	21.1
	20x25	1050	1750	.12	.22	1.0	11	26.4
	24x24	1200	2000	.12	.22	1.0	11	29.3
	25x29	1500	2500	.12	.22	1.0	11	37.1

4.7 Filtration for Central Forced-Air HVAC Systems

Verification

- Can be builder or Rater verified.
- Coordinate with the builder and/or HVAC contractor **before the start of construction** to ensure that:
  - no ozone-producing air-cleaning equipment will be installed AND
  - a MERV 8 filter is accomodated in the HVAC design.
- **Visually verify at final inspection** that the filter has been installed.

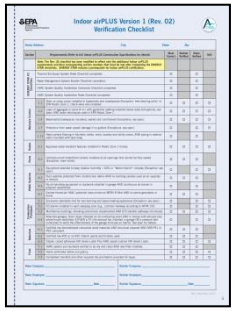
Section		Requirements (Refer to full Indoor airPLUS Construction Specifications for details)	Must Correct	Builder Verified	Rater Verified	N/A
HVAC Systems	4.1	Equipment selected to keep relative humidity < 60% in "Warm-Humid" climates (Exception: see spec).	☐		■	☐
	4.2	Duct systems protected from construction debris AND no building cavities used as air supplies or returns.	☐	☐	■	
	4.3	No air-handling equipment or ductwork installed in garage AND continuous air barrier in adjacent assemblies.	☐		■	
	4.7	Central forced-air HVAC system(s) have minimum MERV 8 filter AND no ozone generators in home.	☐	☐	■	

4. HVAC Systems

Homeowner Benefits

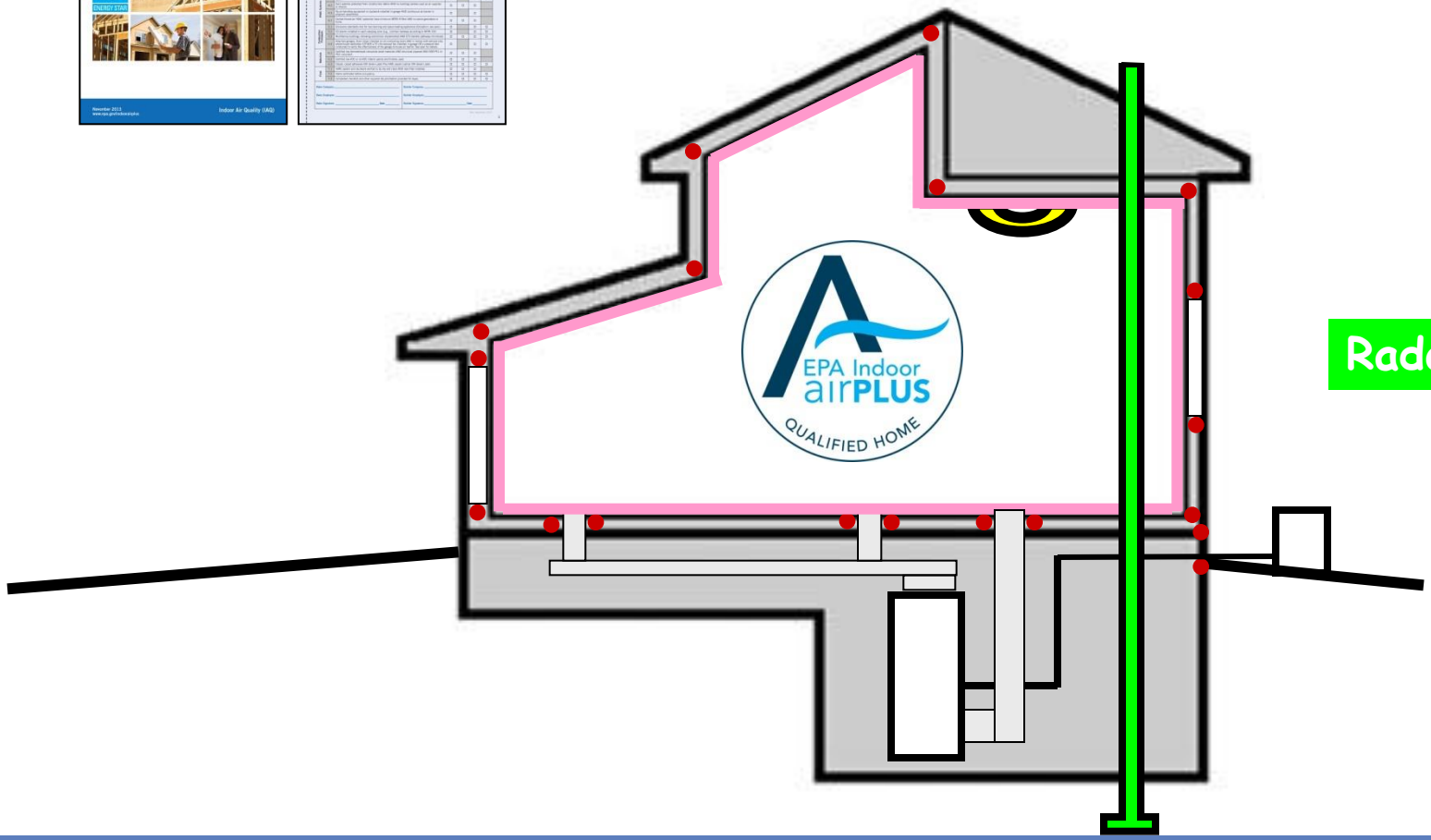
- Reduced exposure to mold and mildew
- Increased comfort
- Helps remove allergens, toxins, irritants and asthma triggers from the home
- House stays cleaner

2. Radon



SURGEON GENERAL'S WARNING:

Radon Causes Lung Cancer.
You Should Test Your Home.

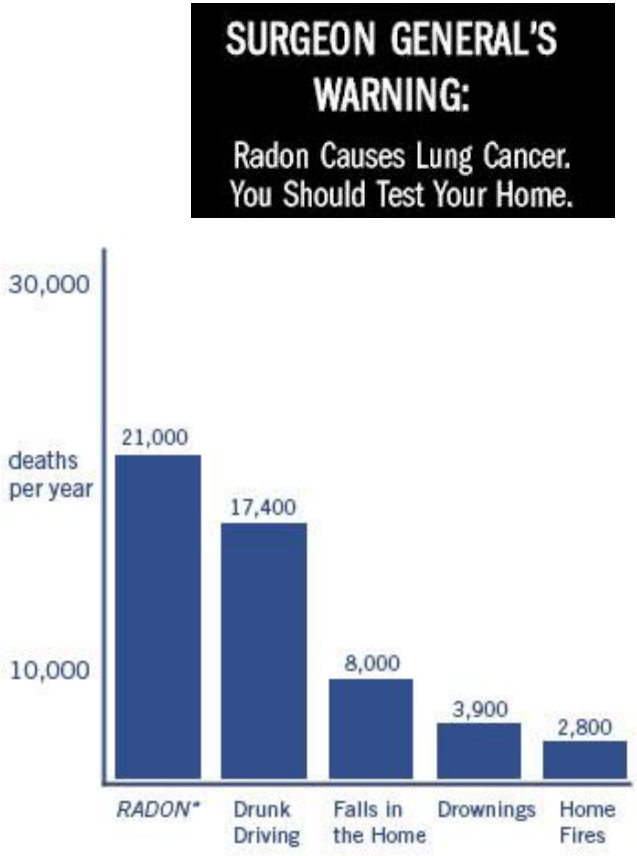


Radon Control

look for EPA Indoor airPLUS QUALIFIED HOMES

Indoor Air Quality (IAQ)

2. Radon



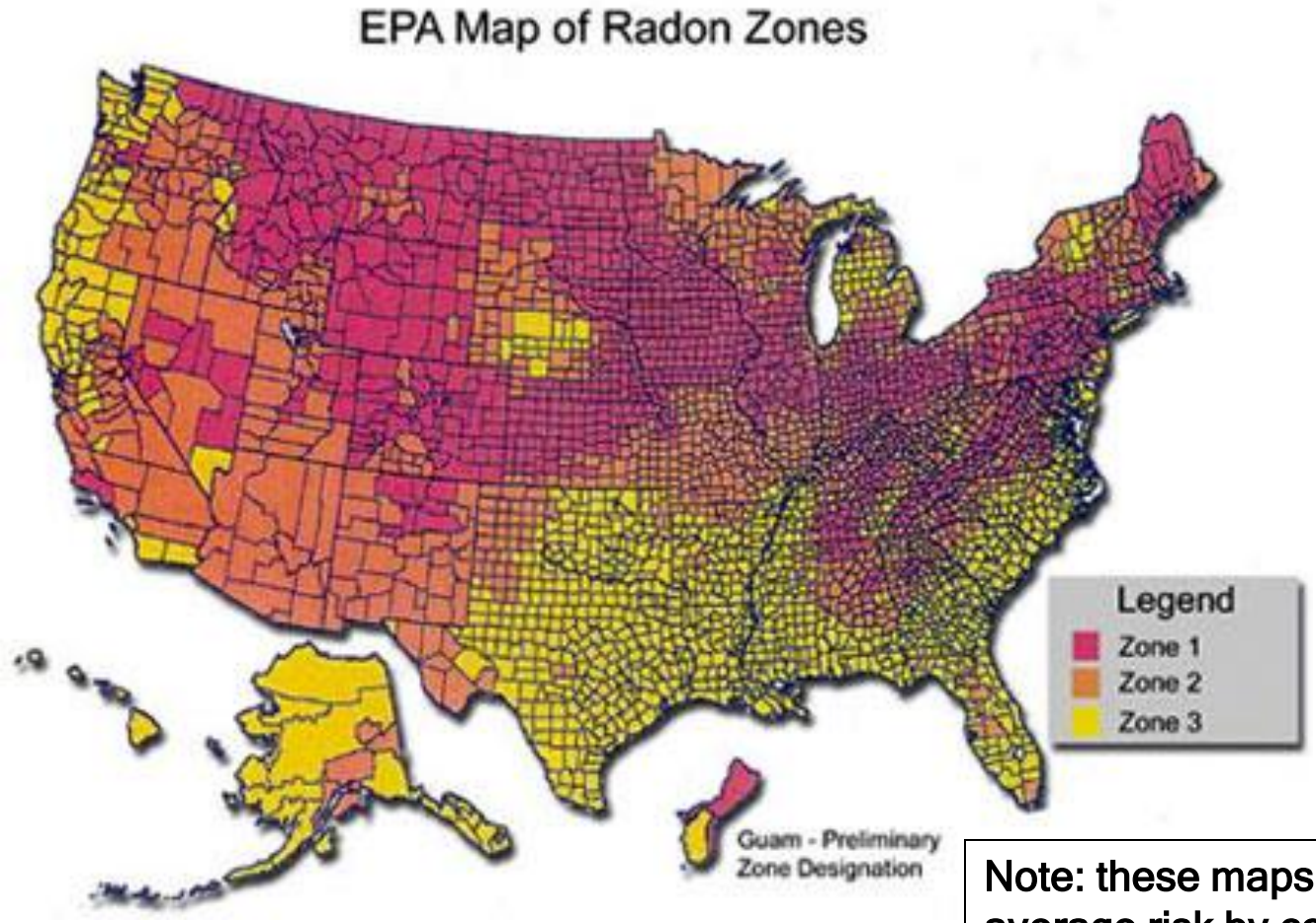
- Radon is a cancer-causing, radioactive gas created by the natural breakdown of uranium in soil.
- Radon can be found all over the US.
- 1 in 15 homes have radon above 4 pCi/L.
- You are most likely to get your greatest exposure to radon at home.
- Radon is the second leading cause of lung cancer after smoking.

2.1 Radon Control

- *Air seal all sump covers.*

- **Construct homes built in EPA Radon Zone 1 with radon-resistant features.**
- **Advisory:**
  - **Passive Systems in Zones 2 & 3.**
  - **Educate homeowners.**

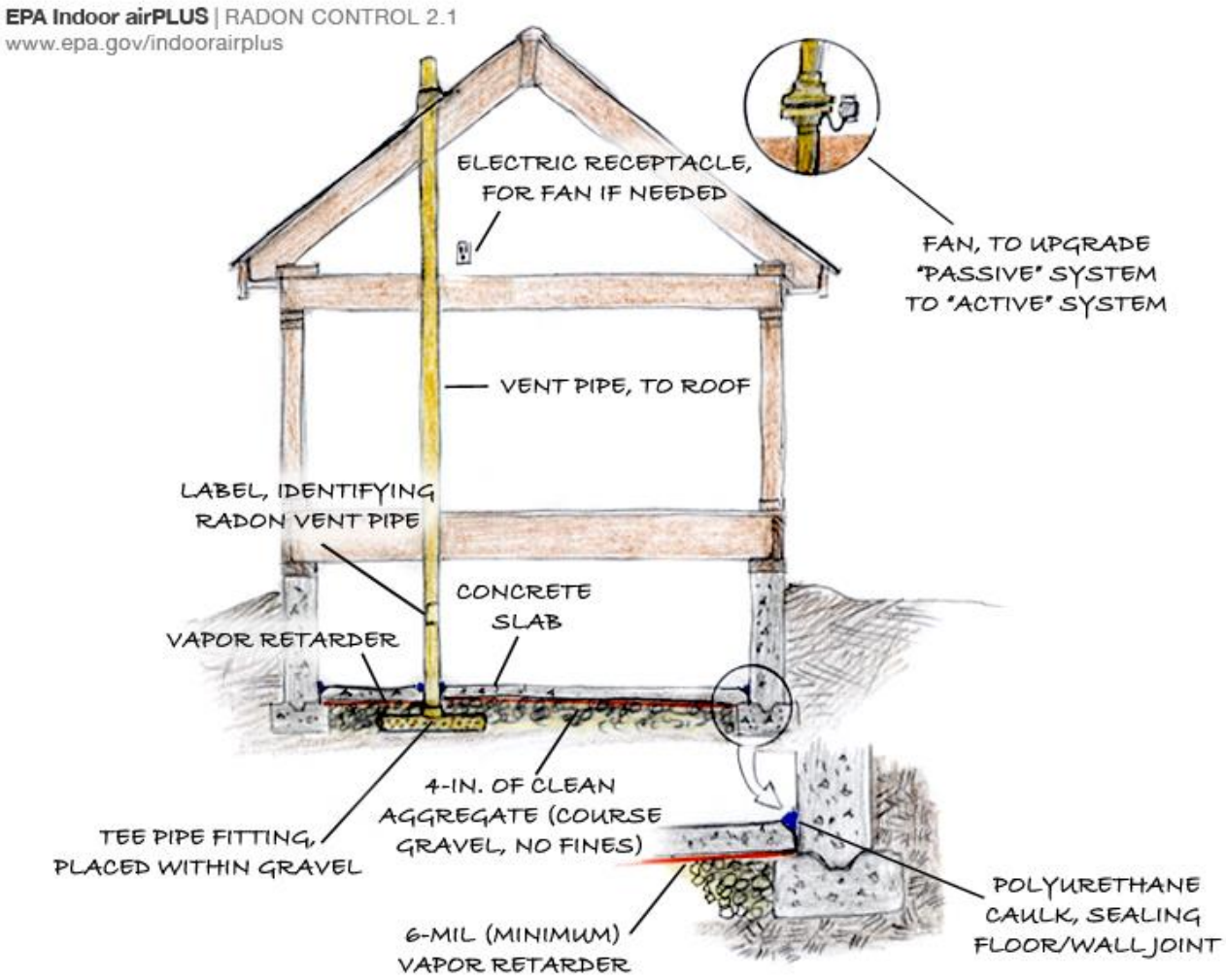
2.1 Radon Control



For an easy-to-use map, see:
http://www.wxplushealth.org/geoexplorer

Note: these maps indicate average risk by county. However, high levels of radon can be found in any home.

2.1 Radon Control



look for EPA Indoor airPLUS QUALIFIED HOMES

Indoor Air Quality (IAQ)

2.1 Radon Resistant Construction

Verification

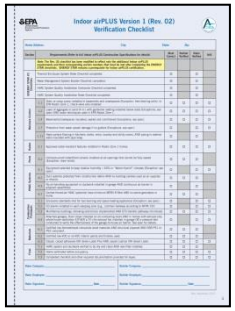
- Can be builder or Rater verified.
- **Verify documentation before the start of construction** of an approved radon mitigation system.
- The aggregate layer, connected to a vent pipe under overlapped polyethylene sheeting, should be **visually verified before pouring the slab**.
- The fully connected vent pipe, fan/electrical receptacle, and foundation air sealing should be **visually verified at pre-drywall inspection**.

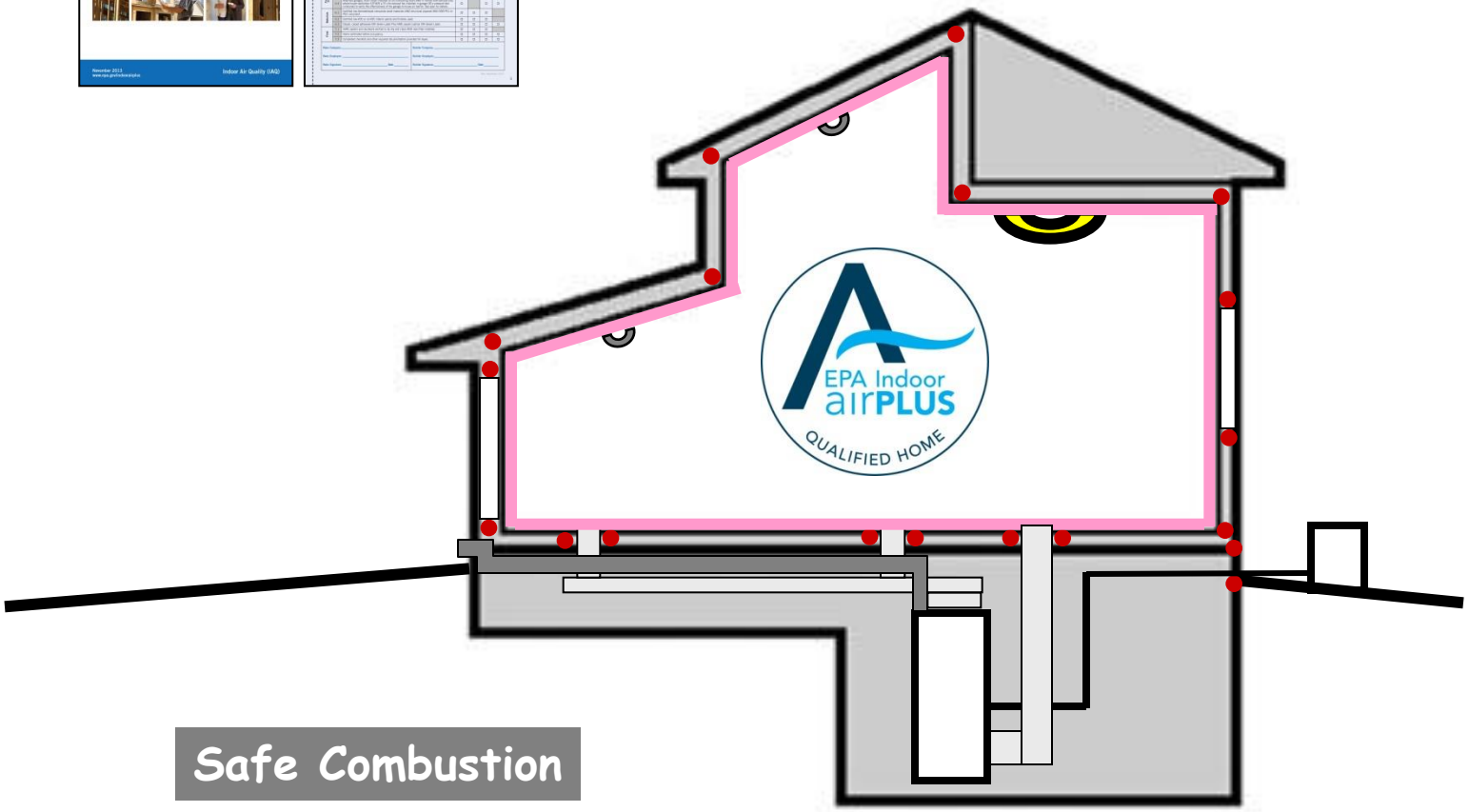
Section	Requirements (Refer to full Indoor airPLUS Construction Specifications for details)		Must Correct	Builder Verified	Rater Verified	N/A
Radon	2.1	Approved radon-resistant features installed in Radon Zone 1 homes.	☐	☐	■	☐

Revision 1 Radon Changes

Section	Changes
2. Radon	
2.1 Radon-Resistant Construction	References Removed: Appendix F; CABO. Advisories Added: Including a radon vent fan and installing radon resistant features in EPA Radon Zones 2 and 3 are recommended. Advisories Added: Radon testing recommended.
2.2 Radon Test Kits	Requirement Removed: Radon test kits are no longer required to be provided to homebuyers.

5. Combustion Pollutants





Safe Combustion

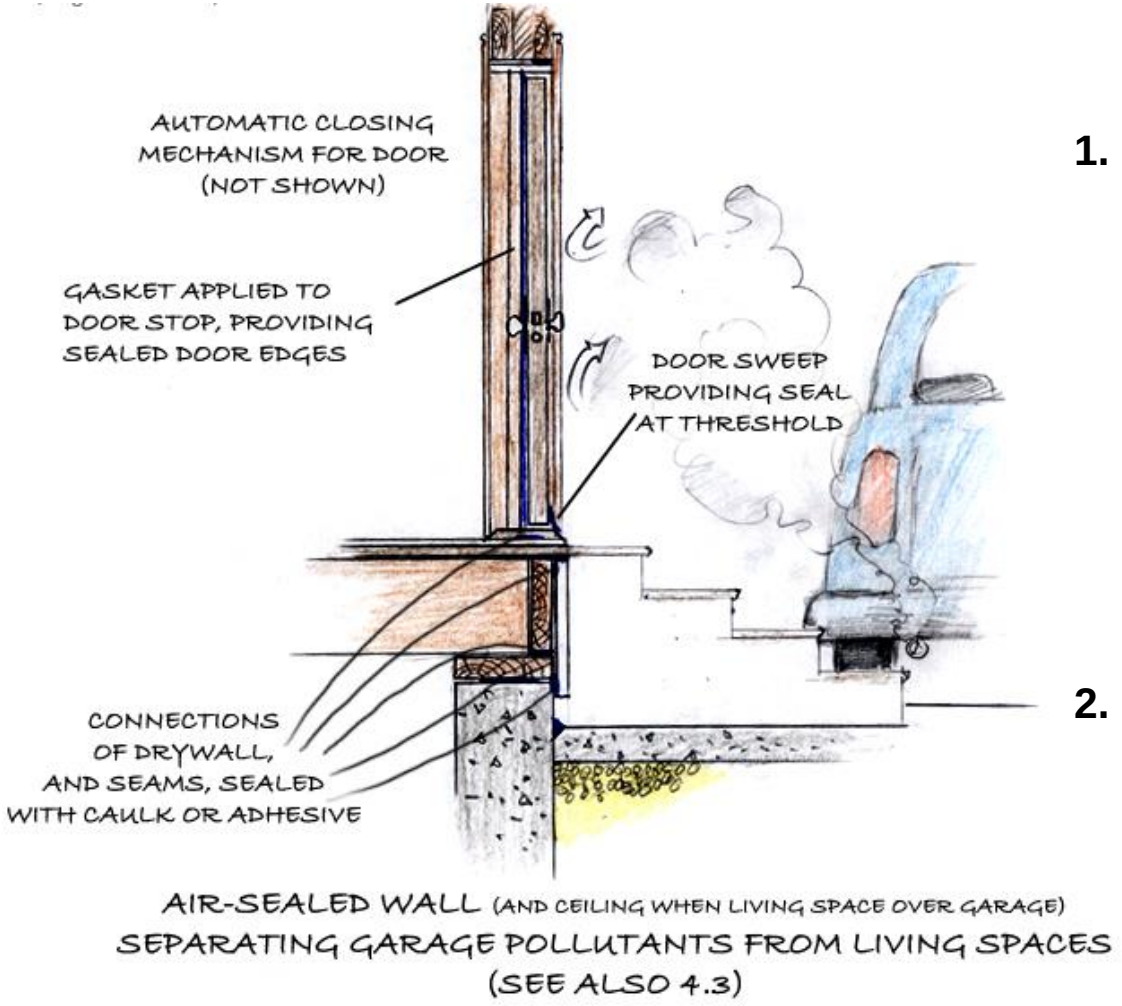
look for EPA Indoor airPLUS QUALIFIED HOMES

Indoor Air Quality (IAQ)

5. Combustion Pollutants

- Accidental carbon monoxide (CO) poisoning kills an average of 439 persons annually (CDC; MMWR; 12/21/2007).
- Carbon monoxide, an odorless, colorless gas, which can cause sudden illness and death, is produced any time a fossil fuel is burned.

5.4 Attached Garages



1. **Isolated** from conditioned spaces:
   - Common walls and ceilings are **air-sealed.**
   - **No HVAC equipment or ducts** in garage
   - **Weather stripping** and an **automatic door closer** is installed on connecting doors between living space and garage.
2. **Appropriate ventilation strategy or pressure testing** ensures separation from living space.

5.4 Attached Garages

- *Isolate attached garages from conditioned spaces:*
  - *Air-seal common walls and ceilings.*
  - *Use weather stripping on all doors between living spaces and attached garages.*

- Install an automatic door closer on all connecting doors between living spaces and attached garages.
- In homes with exhaust-only whole-house ventilation either:
  - Equip the attached garage with an exhaust fan with a minimum installed capacity of 70 cfm that is vented directly outdoors;

    OR
  - Conduct a pressure test to verify the effectiveness of the garage-to-house air barrier.

Note: Requirements for attached garages revised. See November 13, 2013 Policy Record update.

5.4 Attached Garages

Verification

- Rater should **verify proper functioning of the automatic door closer** at final inspection.
- In homes with **exhaust only ventilation system**, at final inspection Rater should:
  - **Visually verify at final inspection** that an appropriate garage fan has been installed.
    - If the garage is ventilated by a ducted fan, a Rater should perform a flow test to confirm the required CFM is being met.

OR

  - **Conduct 45 Pascal pressure test** with all garage openings closed to verify the garage-to-house air barrier.
    - Test can be performed during required ENERGY STAR blower door test
    - If garage-to-house air barrier does not pass pressure test, additional air sealing or a garage fan required.

Section		Requirements (Refer to full Indoor airPLUS Construction Specifications for details)	Must Correct	Builder Verified	Rater Verified	N/A
Combustion Pollutants	5.1	Emissions standards met for fuel-burning and space-heating appliances (Exception: see spec).	☐		■	☐
	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.	☐	■	☐	☐
	5.4	Attached garages: Door closer installed on all connecting doors AND in homes with exhaust-only whole-house ventilation, EITHER a 70 cfm exhaust fan installed in garage OR a pressure test conducted to verify the effectiveness of the garage-to-house air barrier. See spec for details.	☐		■	☐

Combustion Pollutants

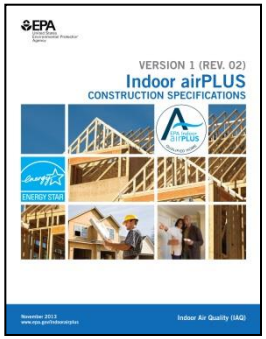
Benefits

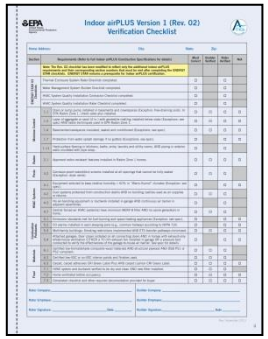
Reduced exposure to carbon monoxide.

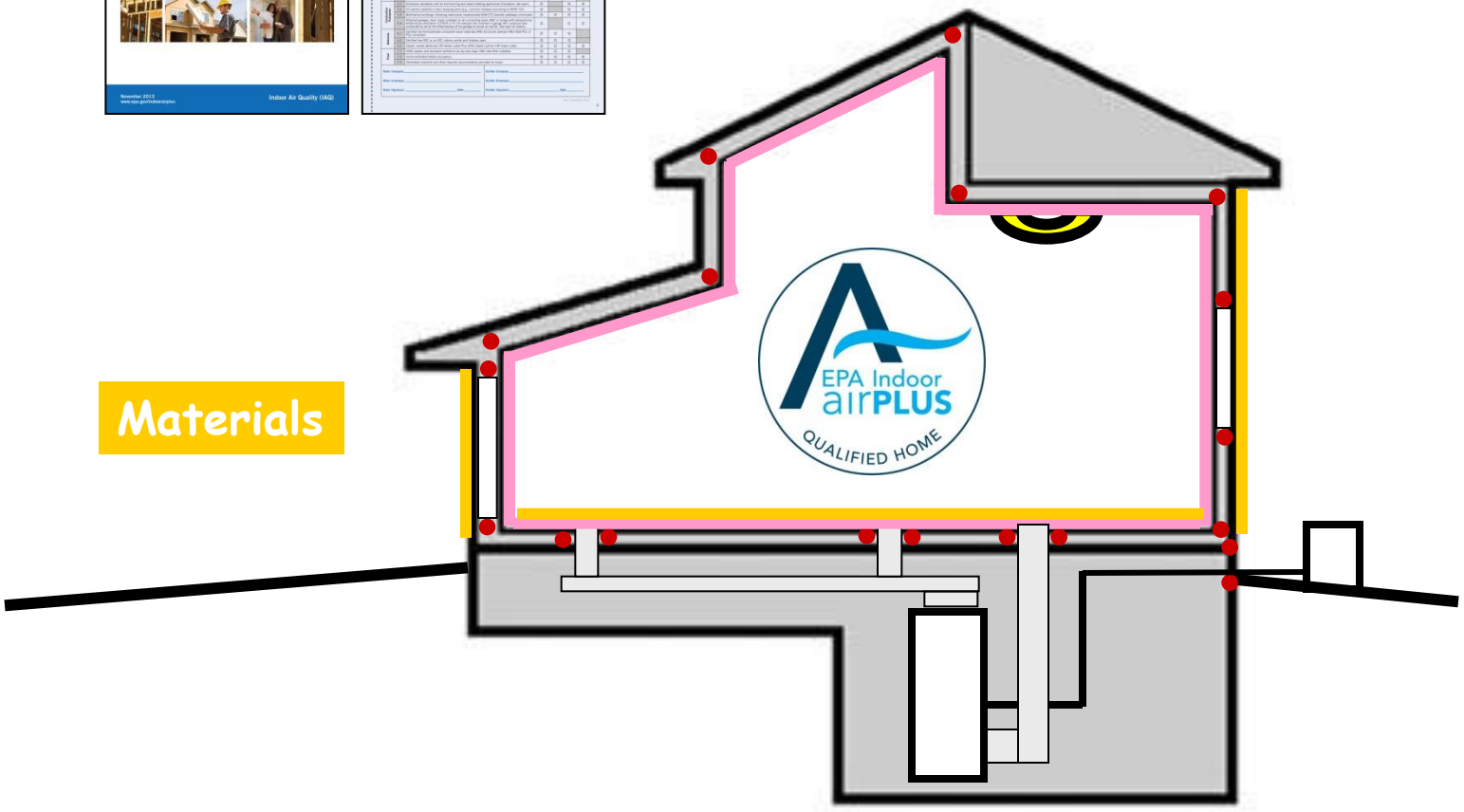
Pollutants in attached garages isolated from living space.

Round-the-clock peace of mind.

6. Low Emission Materials







Materials

look for EPA Indoor airPLUS QUALIFIED HOMES

Indoor Air Quality (IAQ)

6. Low Emission Materials

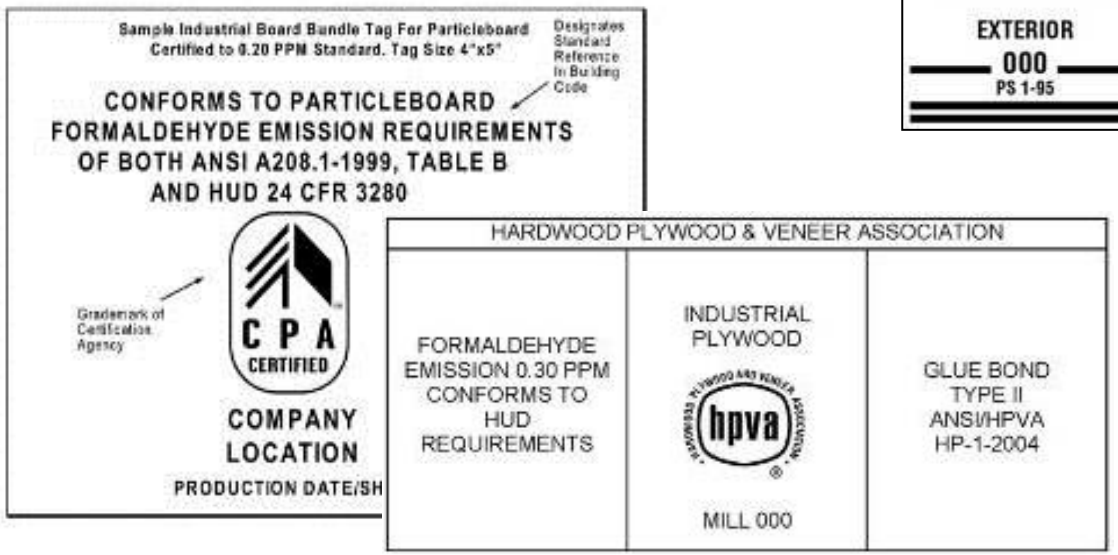
Potential Issues:

- Indoor levels of many chemical pollutants can be **2-5 times higher than outdoor levels**.

- Volitile Organic Copounds (**VOCs**) include a variety of chemicals, some of which may have short- and long-term adverse health effects, including eye, nose, and throat irritation, headaches, loss of coordination, nausea, damage to liver, kidney, and central nervous system.

6.1 Composite Wood

- *Structural plywood is rated for **durability and moisture resistance** (PS1 or PS2)*
- *Composite wood is certified as **low-formaldehyde** (see spec for referenced standards)*



6.2 Interior Paints and Finishes

- *Interior paints and finishes are certified as* ***low-VOC or no-VOC***
  - *Greenseal GS11*
  - *Greenguard*
  - *Scientific Certification Systems*
  - *Master Painters Institute*
  - *Verified using CA 01350(CDPH Standard Method V1.1-2010).*

6.3 Carpets and Carpet Adhesives

- Use carpets and carpet adhesives labeled with the Carpet and Rug Institute (CRI) Green Label Plus testing program criteria.
  - Note: at least 90% of carpeted area

- For carpet cushion (i.e., padding), use only products certified to meet the CRI Green Label testing program criteria.

6.3 Carpets and Carpet Adhesives

Verification

- Can be builder or Rater verified.
- **Verify documentation before the start of construction** that paints and finishes, carpet and carpet adhesives, and composite wood products will all meet the required emissions standards.

Section		Requirements (Refer to full Indoor airPLUS Construction Specifications for details)	Must Correct	Builder Verified	Rater Verified	N/A
Materials	6.1	Certified low-formaldehyde composite wood materials AND structural plywood AND OSB PS1 or PS2 compliant.	☐	■	☐	
	6.2	Certified low-VOC or no-VOC interior paints and finishes used.	☐	■	☐	
	6.3	Carpet, carpet adhesives CRI Green Label Plus AND carpet cushion CRI Green Label.	☐	■	☐	☐

6. Low Emission Materials

Homeowner Benefits

- Less “chemical” smell
- Lowered exposure to VOCs
- Reduced potential for occupant health complaints

7.2 Ventilation after Material Installation

- **Verify that the home has been ventilated with outside air:**
  - **During and shortly after installing products that are known sources of contaminants, AND**
  - **During the period between finishing and occupancy.**

7.1 HVAC and Duct Verification

Verification

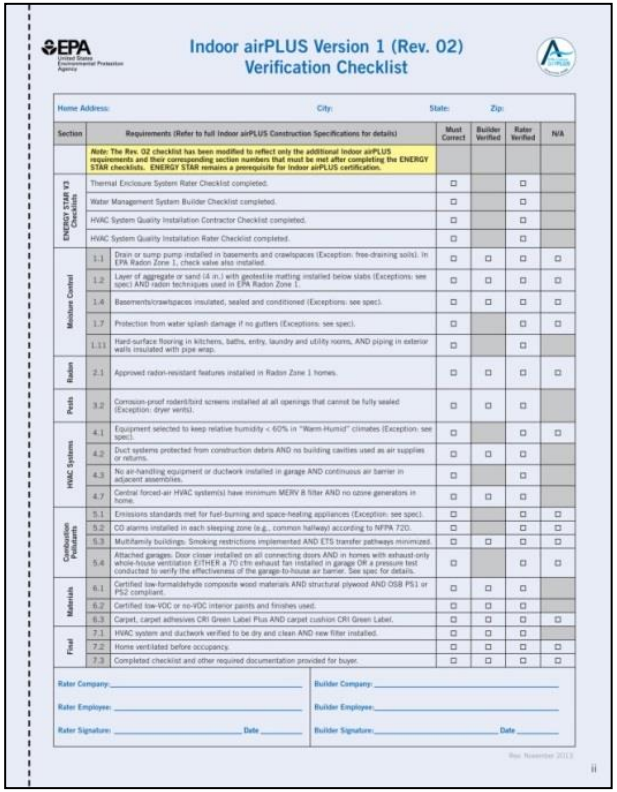
- Can be builder or Rater verified.
- **Visually verify at final inspection** that the ductwork and air-handling equipment is substantially free of dust and debris.
- **The home has been ventilated with outside air:**
  - During and shortly after installing products that are known sources of contaminants, AND
  - During the period between finishing and occupancy.
- The builder should **provide a buyer information kit** provided to the homebuyer.

Section		Requirements (Refer to full Indoor airPLUS Construction Specifications for details)	Must Correct	Builder Verified	Rater Verified	N/A
Final	7.1	HVAC system and ductwork verified to be dry and clean AND new filter installed.	☐	☐	■	
	7.2	Home ventilated before occupancy.	☐	☐	■	☐
	7.3	Completed checklist and other required documentation provided for buyer.	☐	☐	■	☐

7.3 Buyer Information Kit

- Provide buyers with information and documentation of the home's IAQ protections, including:
  - A copy of the **Indoor airPLUS Verification Checklist.**
  - HVAC, duct, and ventilation system **design documentation.**
  - **Operations and maintenance instruction manuals** for all installed equipment and systems addressed by Indoor airPLUS and ENERGY STAR requirements.

That's it. You're ready to build & label Indoor airPLUS homes!



EPA

Indoor airPLUS Version 1 (Rev. 02)
Verification Checklist

Home Address: City: State: Zip:

Section		Requirements (Refer to full Indoor airPLUS Construction Specifications for details)	Must Correct	Builder Verified	Rater Verified	N/A
		Note: The Rev. 02 checklist has been modified to reflect only the additional Indoor airPLUS requirements and their corresponding section numbers that must be met after completing the ENERGY STAR checklists. ENERGY STAR remains a prerequisite for Indoor airPLUS certification.				
ENERGY STAR V3 Checklists		Thermal Enclosure System Rater Checklist completed.	☐		☐	
		Water Management System Builder Checklist completed.	☐		☐	
		HVAC System Quality Installation Contractor Checklist completed.	☐		☐	
		HVAC System Quality Installation Rater Checklist completed.	☐		☐	
Moisture Control	1.1	Drain or sump pump installed in basements and crawlspaces (Exception: free-draining soils). In EPA Radon Zone 1, check valve also installed.	☐	☐	☐	☐
	1.2	Layer of aggregate or sand (4 in.) with geotextile matting installed below slabs (Exceptions: see spec) AND radon techniques used in EPA Radon Zone 1.	☐	☐	☐	☐
	1.4	Basements/crawlspaces insulated, sealed and conditioned (Exceptions: see spec).	☐	☐	☐	☐
	1.7	Protection from water splash damage if no gutters (Exceptions: see spec).	☐		☐	☐
	1.11	Hard-surface flooring in kitchens, baths, entry, laundry and utility rooms, AND piping in exterior walls insulated with pipe wrap.	☐		☐	
Radon	2.1	Approved radon-resistant features installed in Radon Zone 1 homes.	☐	☐	☐	☐
Pests	3.2	Corrosion-proof rodent/bird screens installed at all openings that cannot be fully sealed (Exception: dryer vents).	☐	☐	☐	
HVAC Systems	4.1	Equipment selected to keep relative humidity < 60% in "Warm-Humid" climates (Exception: see spec).	☐		☐	☐
	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 AND continuous air barrier in adjacent assemblies.	☐		☐	
	4.7	Central forced-air HVAC system(s) have minimum MERV 8 filter AND no ozone generators in home.	☐	☐	☐	
Combustion Pollutants	5.1	Emissions standards met for fuel-burning and space-heating appliances (Exception: see spec).	☐		☐	☐
	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.	☐	☐	☐	☐
	5.4	Attached garages: Door closer installed on all connecting doors AND in homes with exhaust-only whole-house ventilation EITHER a 70 cfm exhaust fan installed in garage OR a pressure test conducted to verify the effectiveness of the garage-to-house air barrier. See spec for details.	☐		☐	☐
Materials	6.1	Certified low-formaldehyde composite wood materials AND structural plywood AND OSB PS1 or PS2 compliant.	☐	☐	☐	
	6.2	Certified low-VOC or no-VOC interior paints and finishes used.	☐	☐	☐	
	6.3	Carpet, carpet adhesives CRI Green Label Plus AND carpet cushion CRI Green Label.	☐	☐	☐	☐
Final	7.1	HVAC system and ductwork verified to be dry and clean AND new filter installed.	☐	☐	☐	
	7.2	Home ventilated before occupancy.	☐	☐	☐	☐
	7.3	Completed checklist and other required documentation provided for buyer.	☐	☐	☐	☐

Rater Company: Builder Company:

Rater Employee: Builder Employee:

Rater Signature: Date Builder Signature: Date

Rev. November 2013

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One additional checklist verified by the Rater

Place the Indoor airPLUS label adjacent to the ENERGY STAR label

What does Indoor airPLUS cost?

- No fee to participate in the EPA program.
- Raters may charge a verification fee.
- Cost of additional Indoor airPLUS features will vary based on:
  - Local code requirements and typical building practices
  - Climate Zone (e.g., moist versus dry)
  - Radon Zone
  - Availability of suppliers and cost of materials
  - Type of construction (e.g., below grade foundation or slab on grade)
- Cost of additional features could be a few hundred dollars in dry, non-Radon Zone 1 areas or up to a few thousand dollars in moist climates in Radon Zone 1.

Differentiate Your Company

More than 25 million people, including 7.1 million children, have asthma and there is a 20-50% increased risk of asthma in damp houses.

. . . and help your builder do the same.

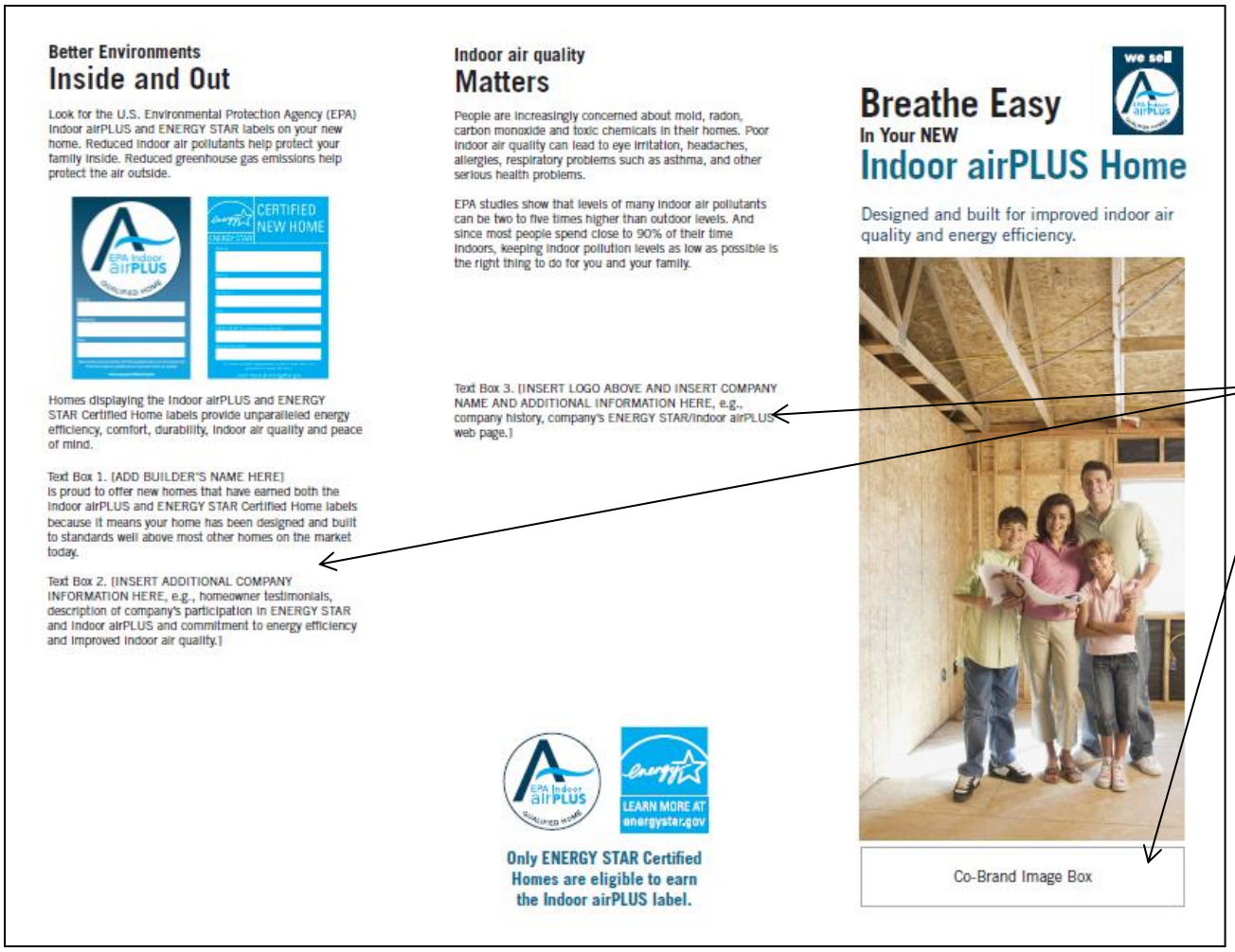
Resources and Tools

Marketing and Technical Support for Partners

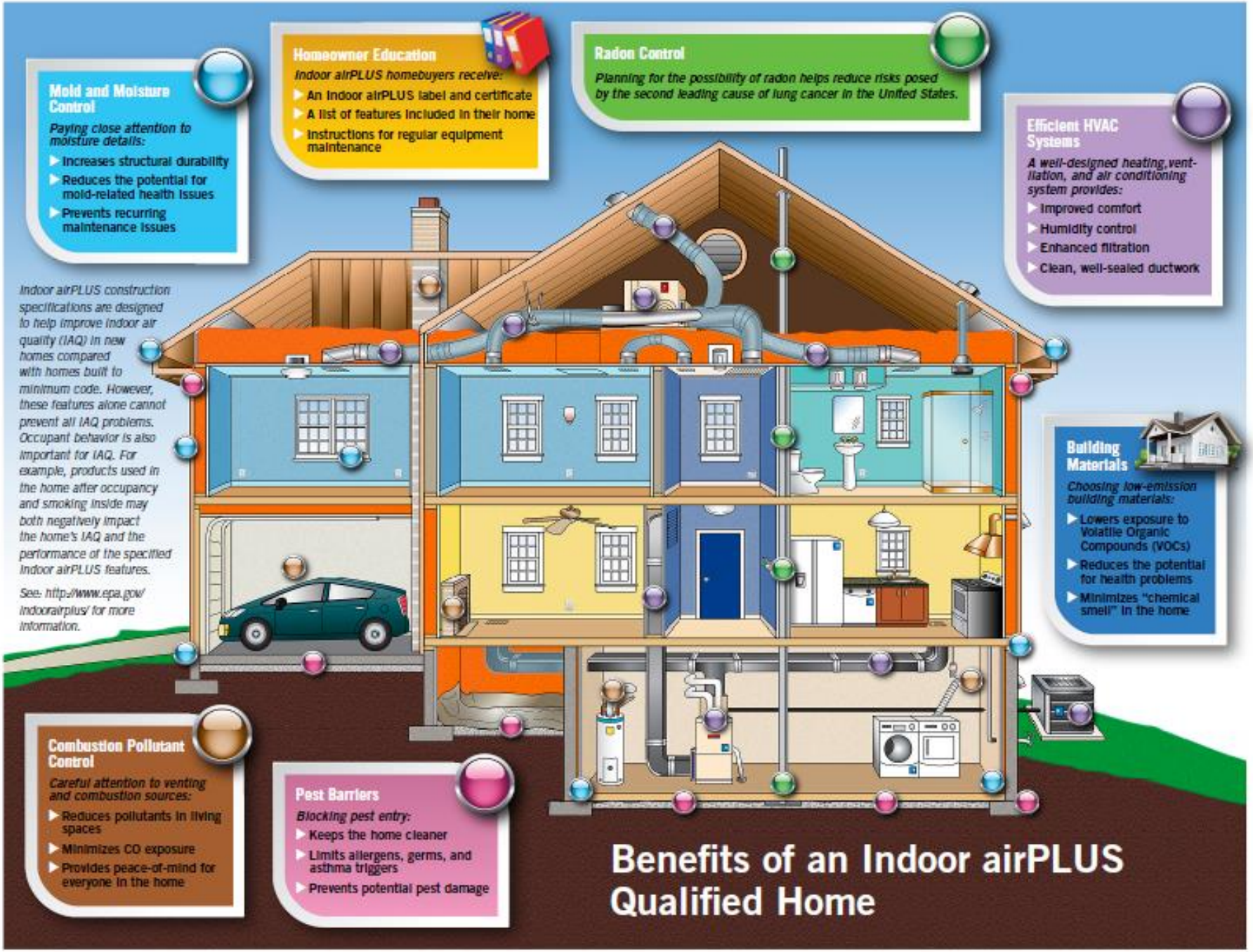
- Builder and consumer resources
- Partner locator
- Website widgets
- Construction Specifications
- Technical guidance

www.epa.gov/indoorairplus

New Marketing Resources



- Co-brandable Brochure *(available soon)*
- Add company name, logo, and other info (testimonials, etc.)


Mold and Moisture Control
Paying close attention to moisture details:
Increases structural durability
Reduces the potential for mold-related health issues
Prevents recurring maintenance issues
Homeowner Education
Indoor airPLUS homebuyers receive:
An Indoor airPLUS label and certificate
A list of features included in their home
Instructions for regular equipment maintenance
Radon Control
Planning for the possibility of radon helps reduce risks posed by the second leading cause of lung cancer in the United States.
Efficient HVAC Systems
A well-designed heating, ventilation, and air conditioning system provides:
Improved comfort
Humidity control
Enhanced filtration
Clean, well-sealed ductwork
Indoor airPLUS construction specifications are designed to help improve indoor air quality (IAQ) in new homes compared with homes built to minimum code. However, these features alone cannot prevent all IAQ problems. Occupant behavior is also important for IAQ. For example, products used in the home after occupancy and smoking inside may both negatively impact the home's IAQ and the performance of the specified Indoor airPLUS features.
See: http://www.epa.gov/indoorairplus/ for more information.
Building Materials
Choosing low-emission building materials:
Lowers exposure to Volatile Organic Compounds (VOCs)
Reduces the potential for health problems
Minimizes "chemical smell" in the home
Combustion Pollutant Control
Careful attention to venting and combustion sources:
Reduces pollutants in living spaces
Minimizes CO exposure
Provides peace-of-mind for everyone in the home
Pest Barriers
Blocking pest entry:
Keeps the home cleaner
Limits allergens, germs, and asthma triggers
Prevents potential pest damage
Benefits of an Indoor airPLUS Qualified Home

Resources and Tools

Get the latest information:

- Facebook
- Twitter
- YouTube Videos
- Mobile App
- Podcasts

http://www.youtube.com/watch?v=vKME1djdIUA

facebook

twitter

YouTube

iTunes

Indoor airPLUS Awards

Recognized Leaders

2013 Indoor airPLUS Leader Award Winners

The Indoor airPLUS Program congratulates its 2013 Leader Award winners:

- ASERusa, St. Louis, MO (a four time winner!)
- E3 Energy, Flagstaff, AZ (a four time winner!)
- Steven Winter Associates, Inc., offices in NY, DC and CT (a two time winner!)

The Indoor airPLUS program presents its Leader Award to the Rater organizations that have demonstrated exceptional commitment to promoting and verifying Indoor airPLUS certified homes in the past year. Eligible Raters must have verified and reported a minimum of 30 homes for 2012. Award winners receive an Indoor airPLUS Leaders plaque, a press release template, and a featured highlight on the Indoor airPLUS website. Winners can use their designation to distinguish themselves as a market leader in the construction and verification of healthier, higher-performing homes.

2010 Award Winners

New Builder Awards – Coming Soon in 2014

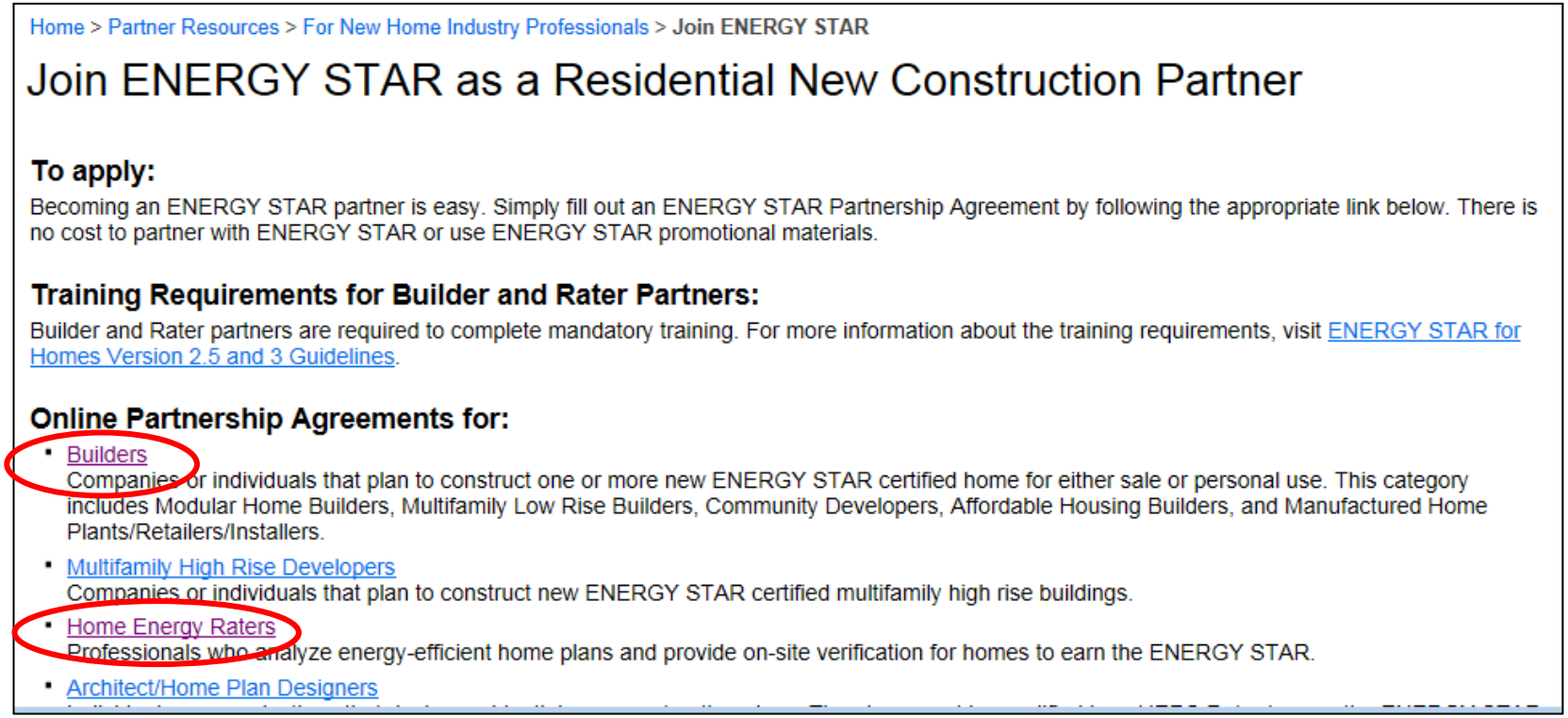
http://epa.gov/iaplus01/verifier_leaders

Become a Partner

Become an Indoor airPLUS Partner

Note: Builders and Raters must also be active ENERGY STAR partners to report Indoor airPLUS homes

- **For *new* ENERGY STAR & Indoor airPLUS Partners, visit:** www.energystar.gov/newhomesPA



Home > Partner Resources > For New Home Industry Professionals > Join ENERGY STAR

Join ENERGY STAR as a Residential New Construction Partner

To apply:

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.

Training Requirements for Builder and Rater Partners:

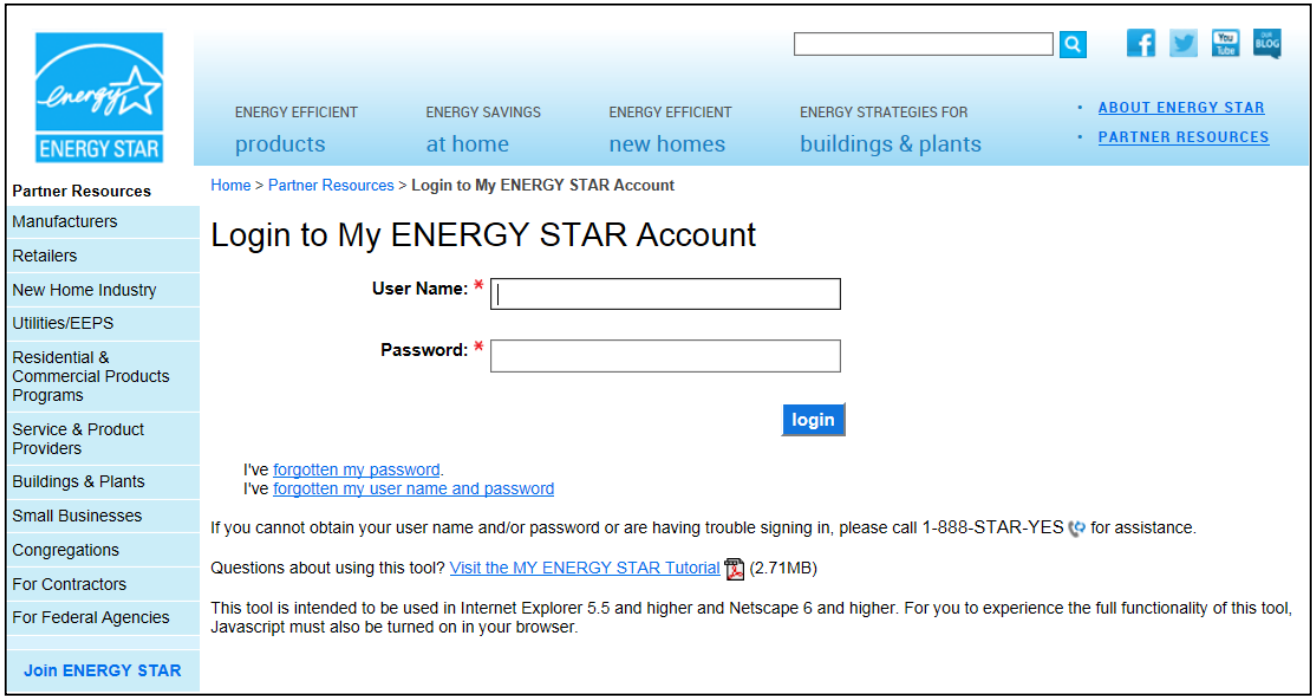
Builder and Rater partners are required to complete mandatory training. For more information about the training requirements, visit ENERGY STAR for Homes Version 2.5 and 3 Guidelines.

Online Partnership Agreements for:

- Builders
  Companies or individuals that plan to construct one or more new ENERGY STAR certified home for either sale or personal use. This category includes Modular Home Builders, Multifamily Low Rise Builders, Community Developers, Affordable Housing Builders, and Manufactured Home Plants/Retailers/Installers.
- Multifamily High Rise Developers
  Companies or individuals that plan to construct new ENERGY STAR certified multifamily high rise buildings.
- Home Energy Raters
  Professionals who analyze energy-efficient home plans and provide on-site verification for homes to earn the ENERGY STAR.
- Architect/Home Plan Designers

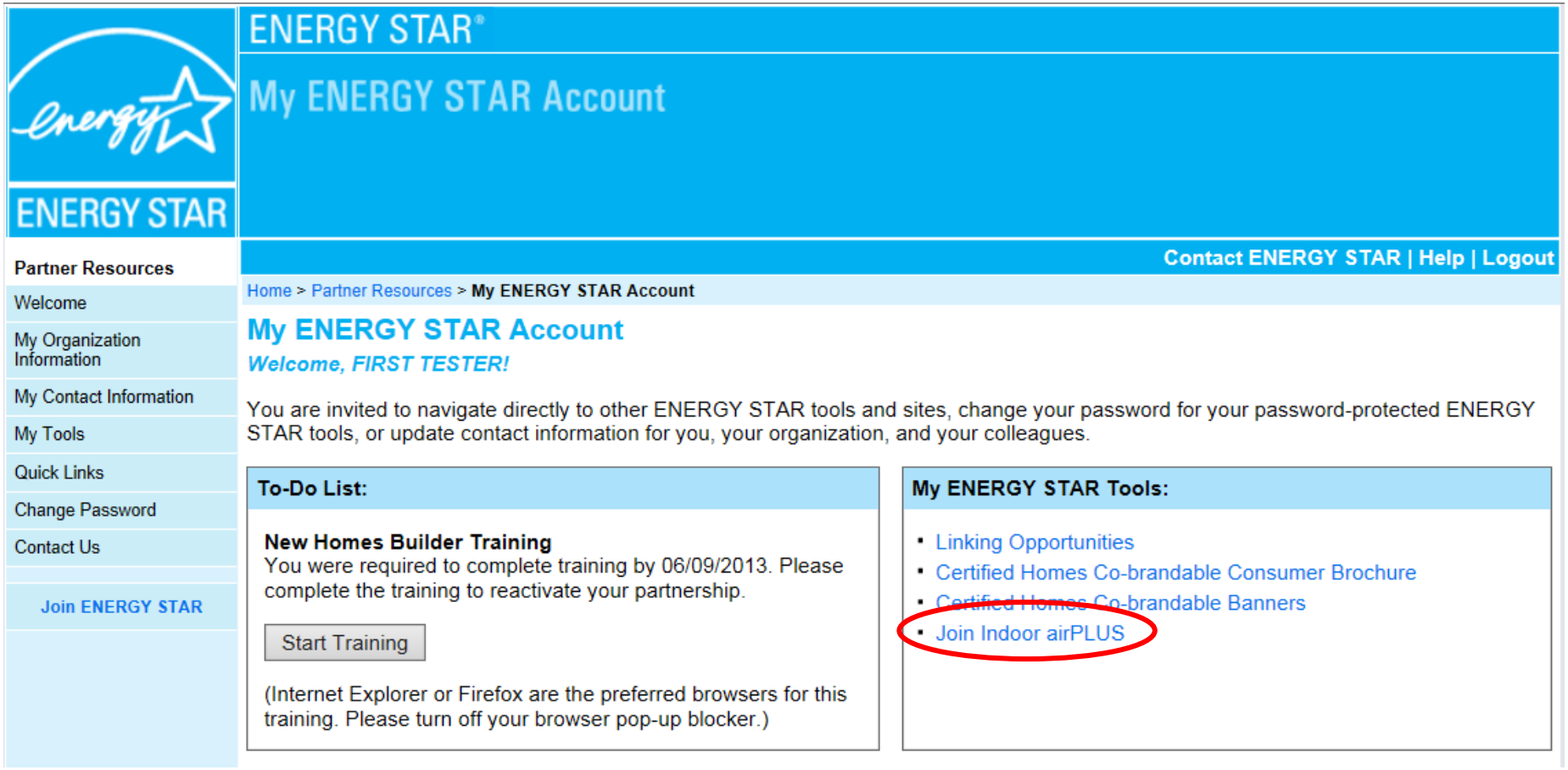
Become an Indoor airPLUS Partner

- For *current* ENERGY STAR Partners:
  - Log into your My ENERGY STAR Account (MESA) www.energystar.gov/mesa
    - If you don't know your user name and password, click the link or email energystarhomes@energystar.gov for assistance.



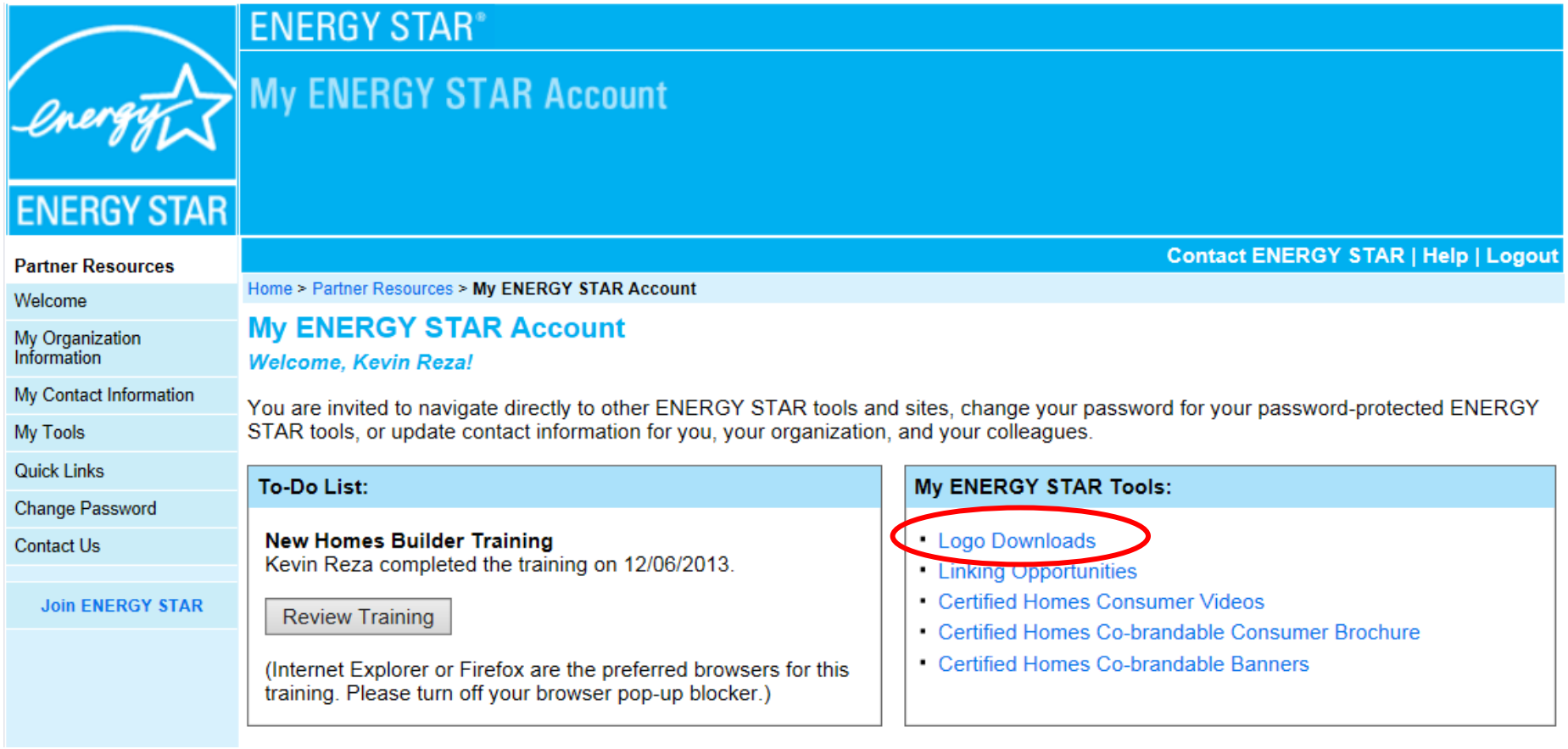
Become an Indoor airPLUS Partner

- After entering your account, click “Join Indoor airPLUS”.
  - For builders, be sure you’ve completed the required ENERGY STAR training.



Become an Indoor airPLUS Partner

- When your partnership is activated, you'll have access to Indoor airPLUS logos.



look for EPA Indoor airPLUS Qualified Homes

Indoor Air Quality (IAQ)

Become an Indoor airPLUS Partner

- Use the logos to promote your partnership and commitment to offering healthier, more durable homes.

Indoor airPLUS Certification Mark

	
Indoor airPLUS Certification Mark (vertical) EPS | JPG	Indoor airPLUS Certification Mark (vertical) EPS | JPG

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Indoor airPLUS Promotional Marks

					
Indoor airPLUS Promotional Marks (vertical) EPS | JPG	Indoor airPLUS Promotional Marks (vertical) EPS | JPG	Indoor airPLUS Promotional Marks (vertical) EPS | JPG	Indoor airPLUS Promotional Marks (vertical) EPS | JPG	Indoor airPLUS Promotional Marks (vertical) EPS | JPG	Indoor airPLUS Promotional Marks (vertical) EPS | JPG

Indoor airPLUS

A new opportunity for leading builders to create better environments inside and out

Learn more at:

www.epa.gov/indoorairplus

OR contact the Indoor airPLUS Team at

indoor_airPLUS@epa.gov