DOE Zero Energy Ready Home

Tech Training Webinar Series

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Indoor airPLUS: Ventilation and Filtration Strategies for Zero Energy Ready Homes

ZERO ENERGY READY HOME
U.S. DEPARTMENT OF ENERGY

The Home of the Future….Today

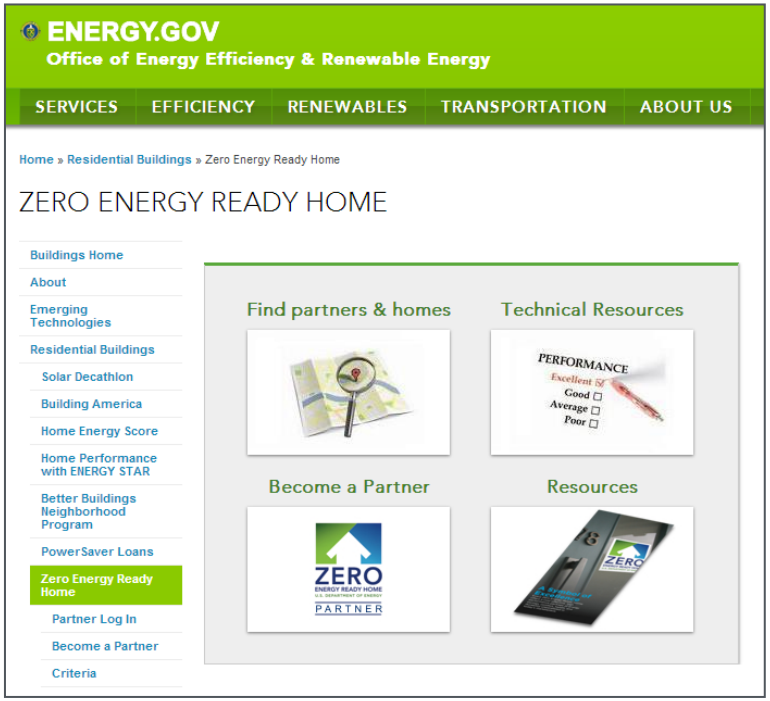
ZERO
ENERGY READY HOME
U.S. DEPARTMENT OF ENERGY

DOE Zero Energy Ready Home Resources

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Website

- www.buildings.energy.gov/zero/
- Events:
  - Upcoming in-person ZERH Trainings
  - Technical Training webinars
  - Conference Presentations
- Partner Locator
- Program Specifications
- Webinar Recordings



Building America Solution Center

- http://basc.pnnl.gov/

Thank You

For More Information:

www.buildings.energy.gov/zero

Email:

doechallengehome@newportpartnersllc.com

EPA United States Environmental Protection Agency

VERSION 1 (REV. 02)

Indoor airPLUS

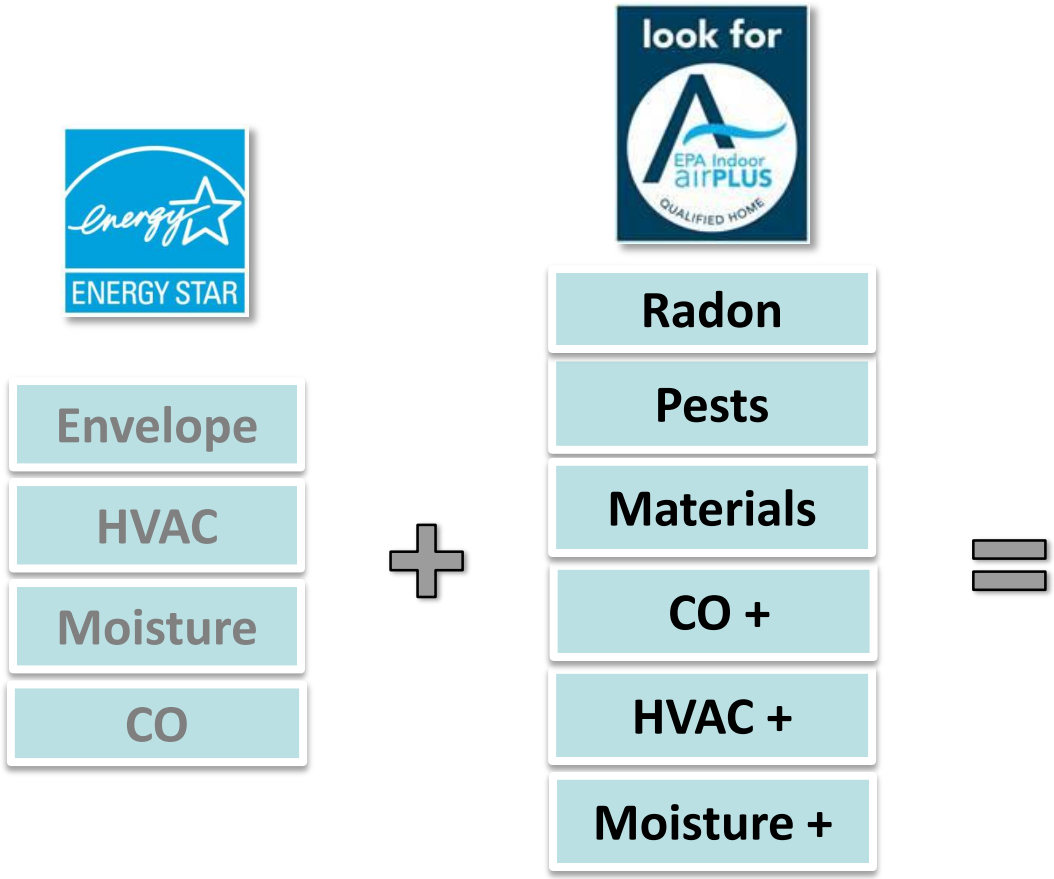
Ventilation and Filtration Strategies with Indoor airPLUS and Zero Energy Ready Homes

ZERO ENERGY READY HOME
U.S. DEPARTMENT OF ENERGY

Contents

- **Recent changes with Indoor airPLUS**
- **New in Rev. 2 – Garage ventilation alternatives**
- **HVAC and IAQ**
  - **HVAC design requirements**
  - **Humidity and moisture**
  - **Filtration**
- **Additional Resources**

ENERGY STAR + Indoor airPLUS



Reducing Health Risks

1. Source Control

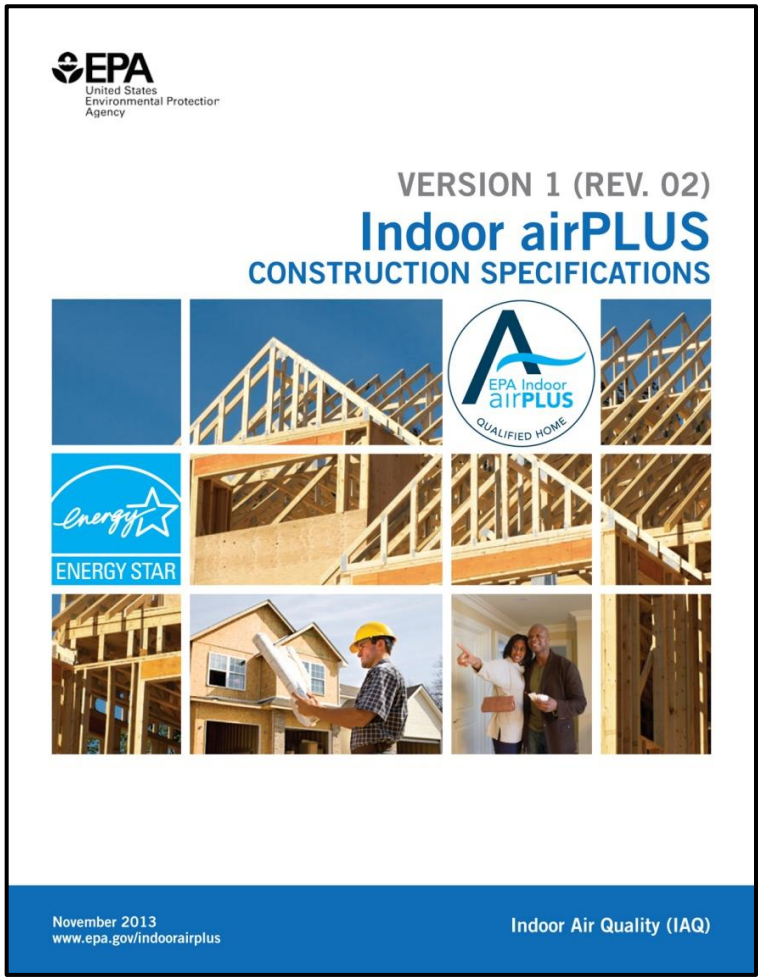
(eliminate or manage)

2. Ventilation

(dilution)

3. Filtration

Revision 2



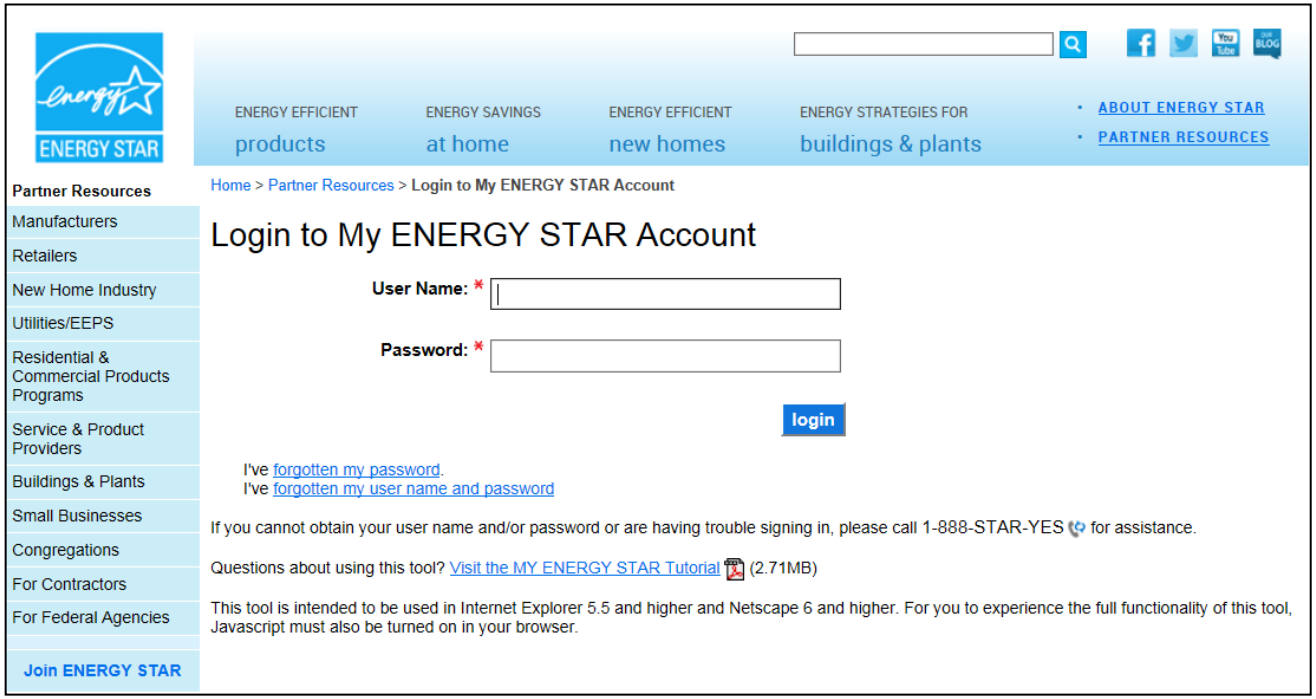
- Released November 2013
- Revised requirements for attached garages
  - Garage fan no longer required for some homes
- New exception from aggregate or sand requirement for slab-on-grade foundations
  - Non-Radon Zone 1 homes only

And now it's easier to join!

look for EPA Indoor airPLUS QUALIFIED HOMES

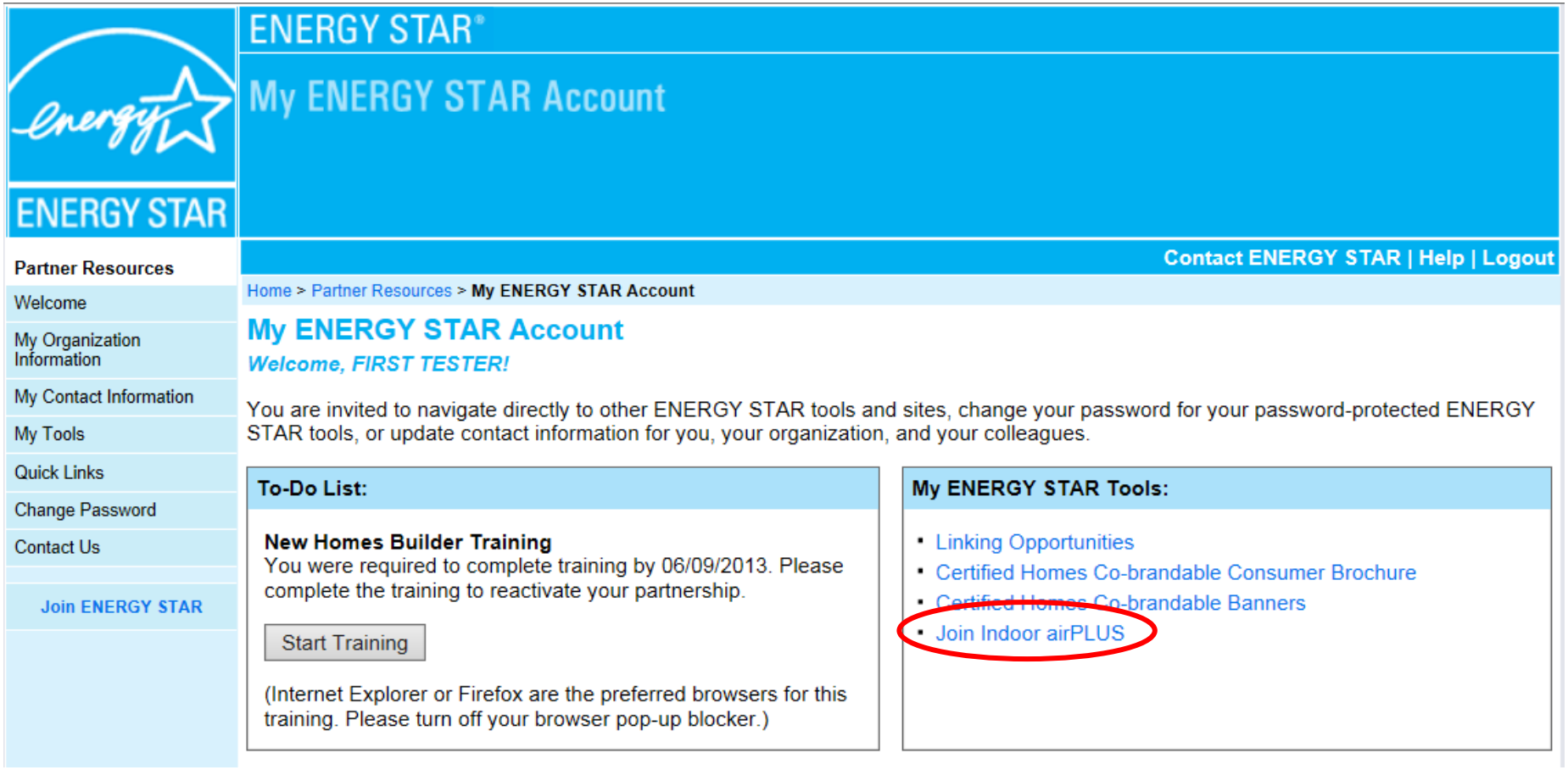
Become an Indoor airPLUS Partner

- 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

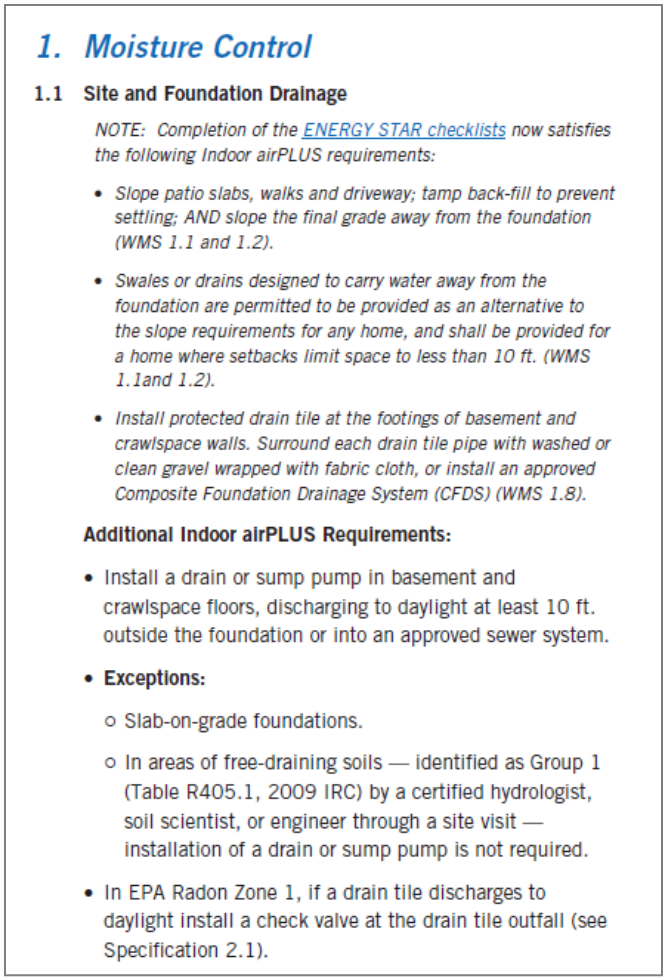
- After entering your account, click “Join Indoor airPLUS”.
  - For builders, be sure you’ve completed the required ENERGY STAR training.



How to use the Construction Specifications

- **Seven sections:**
  - Moisture Control
  - Radon
  - Pests
  - HVAC Systems
  - Combustion Pollutants
  - Materials
  - Home Commissioning

- **Broken down into specific measures to address each IAQ concern.**



1. Moisture Control

1.1 Site and Foundation Drainage

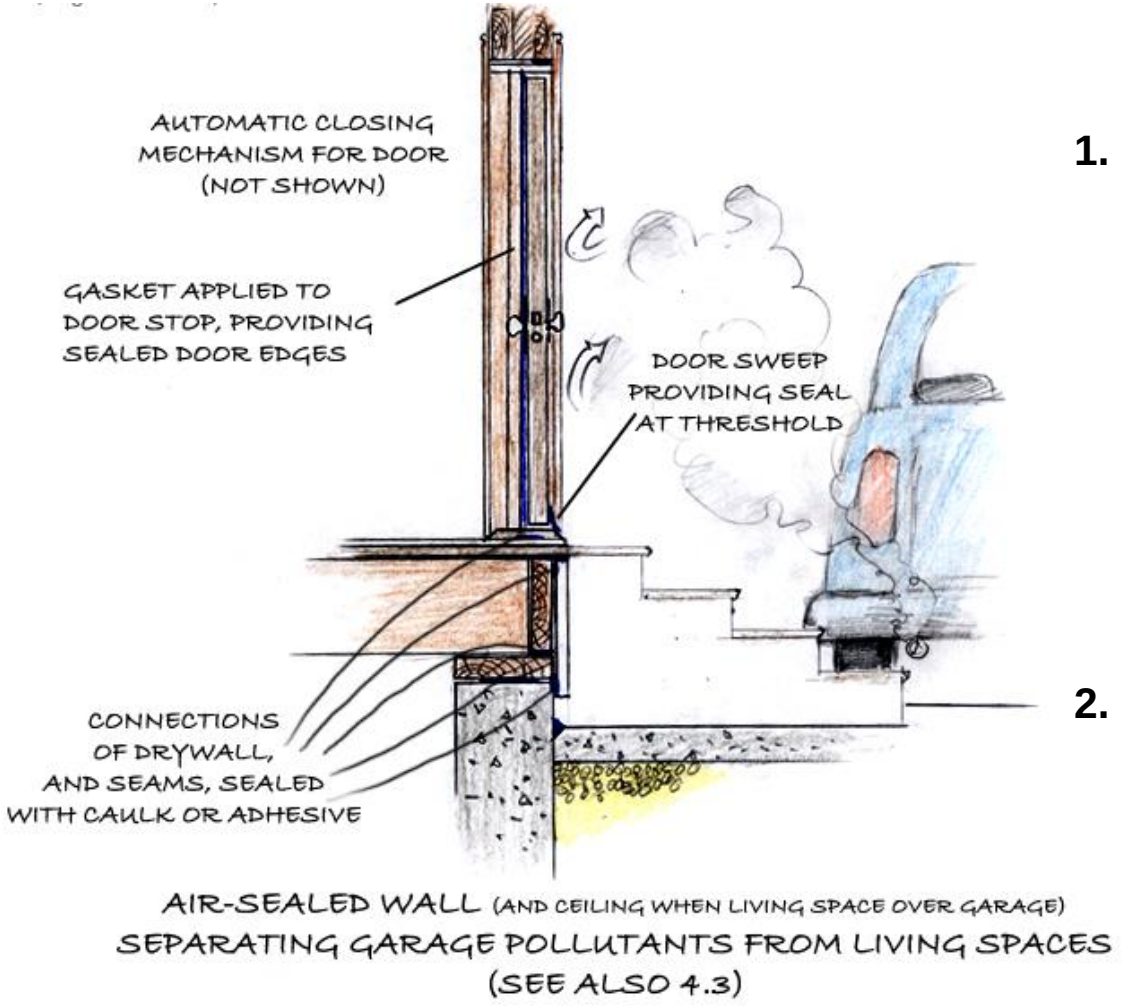
NOTE: Completion of the ENERGY STAR checklists now satisfies the following Indoor airPLUS requirements:

- *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).

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.

Revision 2 Combustion Pollutant Changes

Section	Changes
5. Combustion Pollutant Control	
5.4 Attached Garages	Change: Homes with a **supply-only or balanced whole-house ventilation system** designed to maintain the living space under a positive or neutral pressure relative to the garage are no longer required to install a garage exhaust fan. Homes with **exhaust-only whole house ventilation** must meet one of the following two requirements: -Equip the attached garage with an exhaust fan with a minimum installed capacity of 70 cfm that is vented directly outdoors. **OR** -Verify that the garage-to-house air barrier can maintain a pressure difference of greater than 45 Pascals while the home maintains a 50 Pascal pressure difference with respect to the outdoors. All operable garage openings shall be closed during this test. Advisories Added: See Revision 2 construction specifications.

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

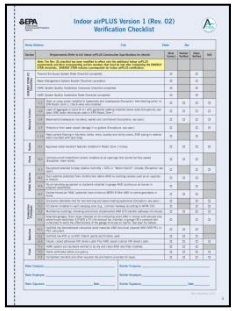
Benefits

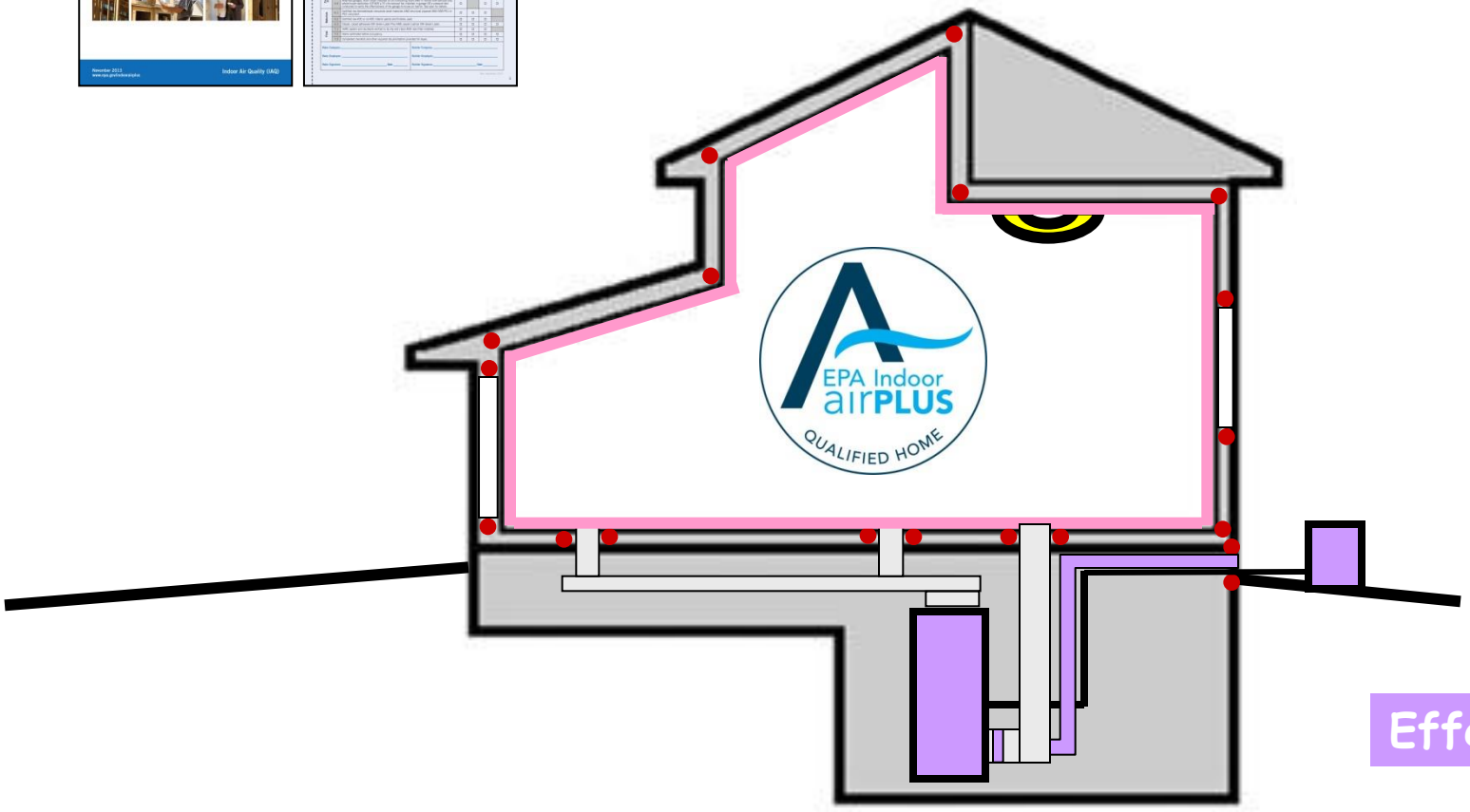
Reduced exposure to carbon monoxide.

Pollutants in attached garages isolated from living space.

Round-the-clock peace of mind.

4. HVAC Systems





Effective HVAC

look for EPA Indoor airPLUS QUALIFIED HOMES

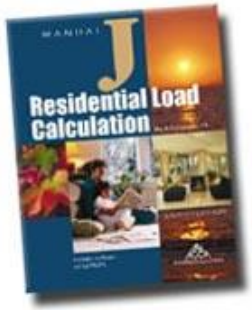
Indoor Air Quality (IAQ)

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.

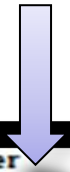
4.1 HVAC Sizing and Design

- *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.**

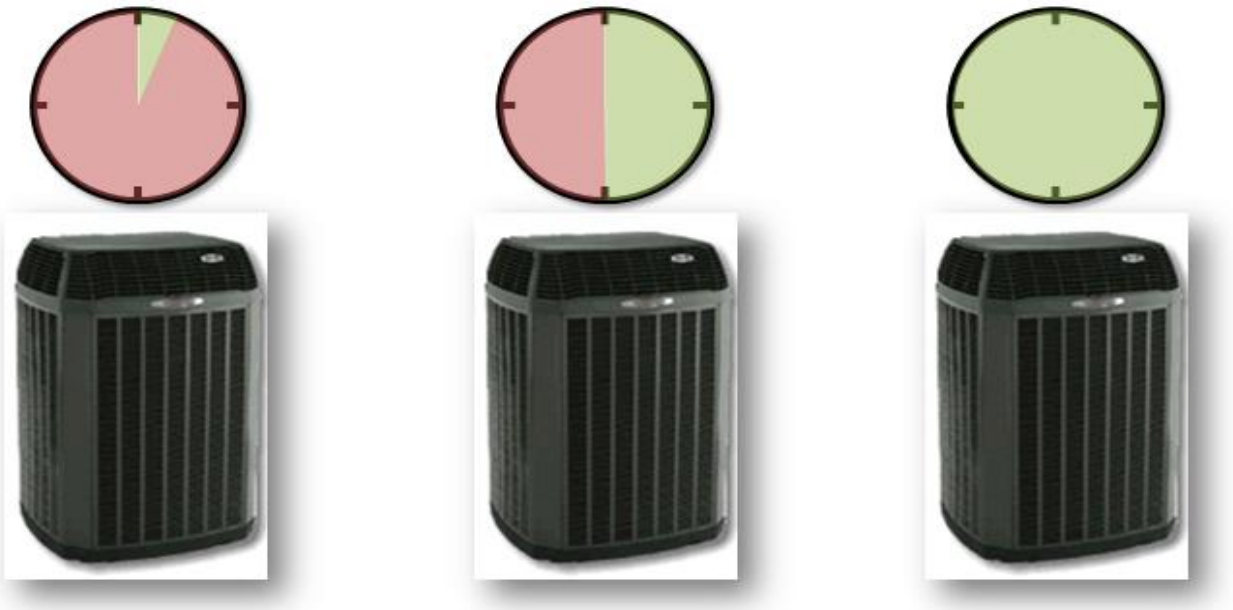
4.1 HVAC Sizing and Design



Location	Elevation Feet	Latitude Degrees North	Winter Heating 99% Dry Bulb	Summer Cooling 1% Dry Bulb	Summer Coincident Wet Bulb	Summer Design Grains 55% RH	Summer Design Grains 50% RH	Summer Design Grains 45% RH	Summer Daily Range (DR)
Montpelier/Barre	1165	44	-6	83	68	8	15	21	M
Rutland	787	43	-8	84	70	18	25	31	M
Virginia									
Charlottsville	870	38	18	91	74	30	37	43	M
Danville AP	572	36	16	92	73	22	29	35	M
Fort Belvoir	69	38	18	93	76	39	46	52	M
Fredricksburg	85	38	14	93	75	33	40	46	M
Hampton, Langley AFB	10	37	24	91	77	49	56	62	M
Harrisonburg	1201	38	16	91	72	18	25	31	M
Lynchburg AP	916	37	17	90	74	31	38	44	M
Newport News	41	37	22	92	77	47	54	60	M
Norfolk AP	22	36	24	91	76	42	49	55	M
Oceana NAS	22	36	25	91	76	42	49	55	M
Petersburg	193	37	17	92	76	41	48	54	M
Quantico MCAS	12	38	21	92	76	41	48	54	M
Richmond AP	164	37	18	92	75	34	41	47	M
Roanoke AP	1193	37	17	89	72	21	28	34	M
Staunton	1201	38	16	91	72	18	25	31	M
Sterling	322	38	14	90	74	31	38	44	M
Washington, National AP	66	38	20	92	76	41	48	54	M
Winchester	727	39	10	90	74	31	38	44	M

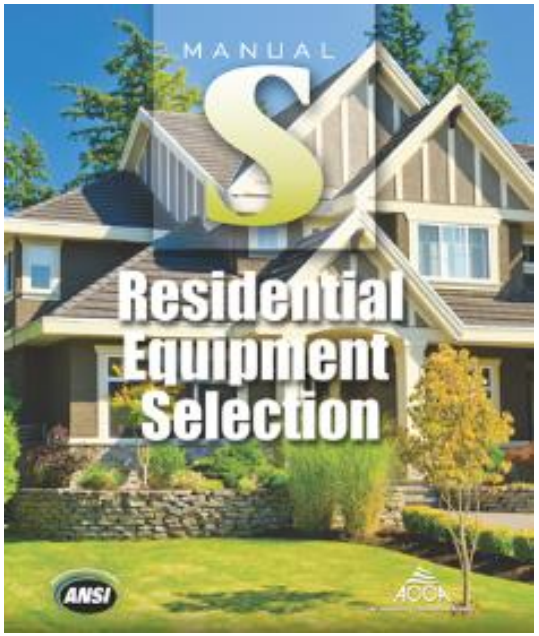
4.1 HVAC Sizing and Design

- 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 !

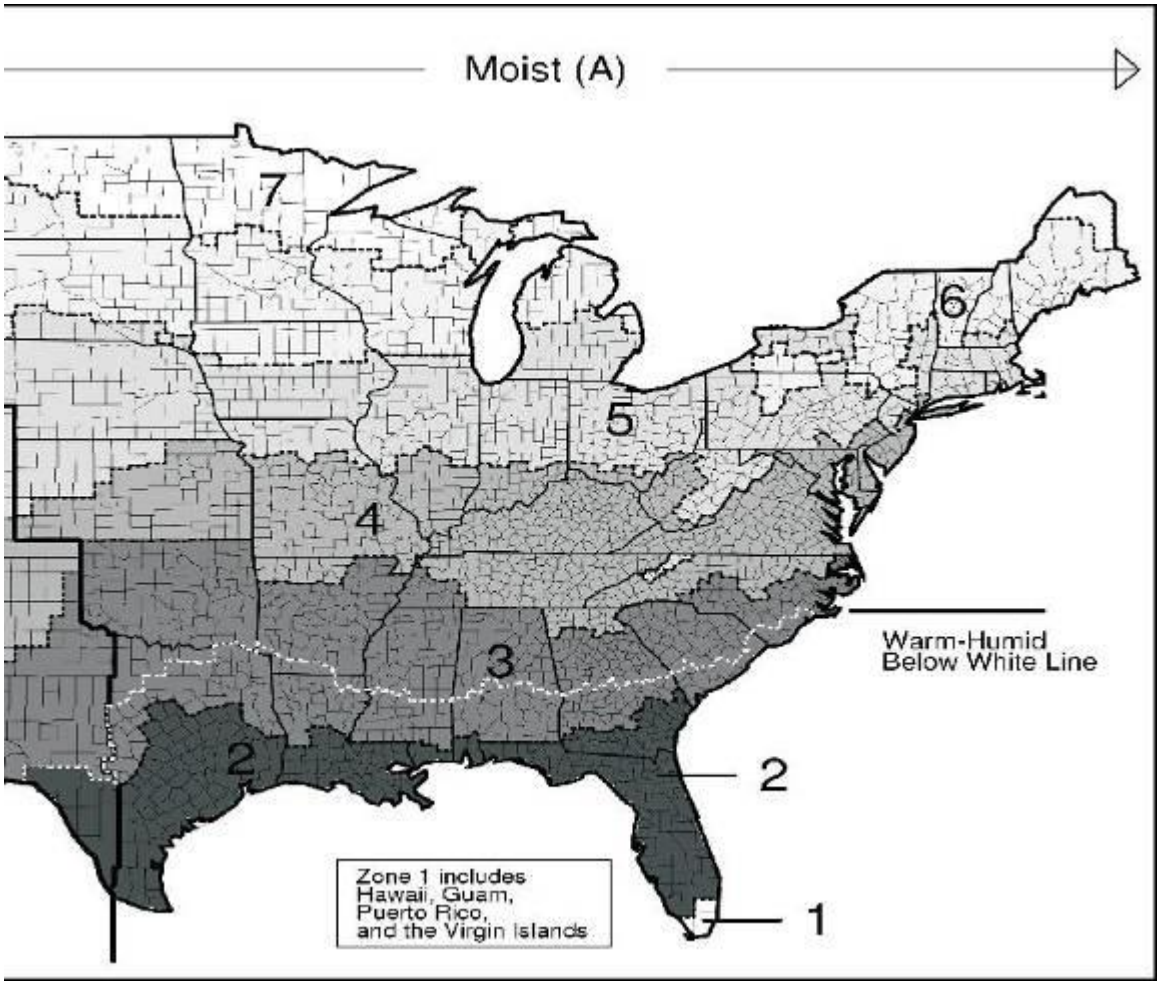


4.1 HVAC Sizing and Design

- **By following the procedures in Manual S for selecting HVAC systems you can ensure the HVAC 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 dehumidification.**
- **In some extreme cases a separate dehumidifier may be required to supplement moisture removal.**



4.1 HVAC Sizing and Design



Controlled to
≤ 60% RH

For IECC climate zone map, visit www.iccsafe.org

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

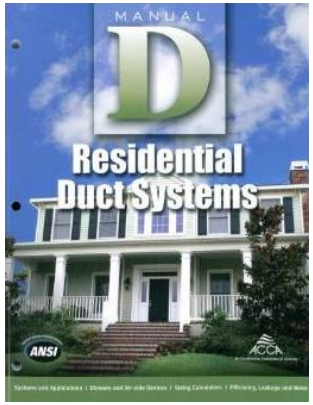
Verification

- 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.*

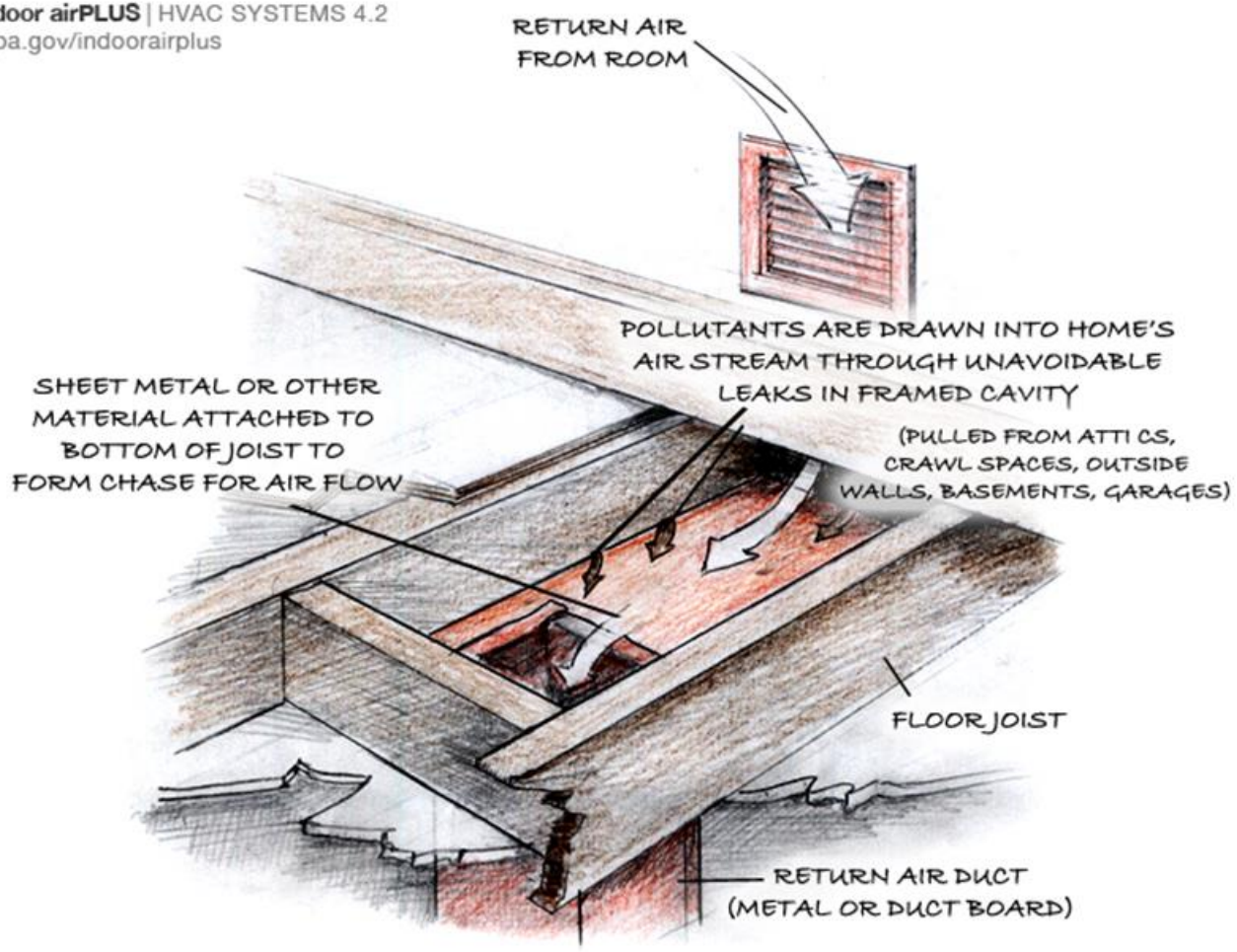


- **Do not use building cavities as part of the forced air supply or return systems.**
- **Cover duct openings throughout construction or vacuum out ducts prior to installing registers.**

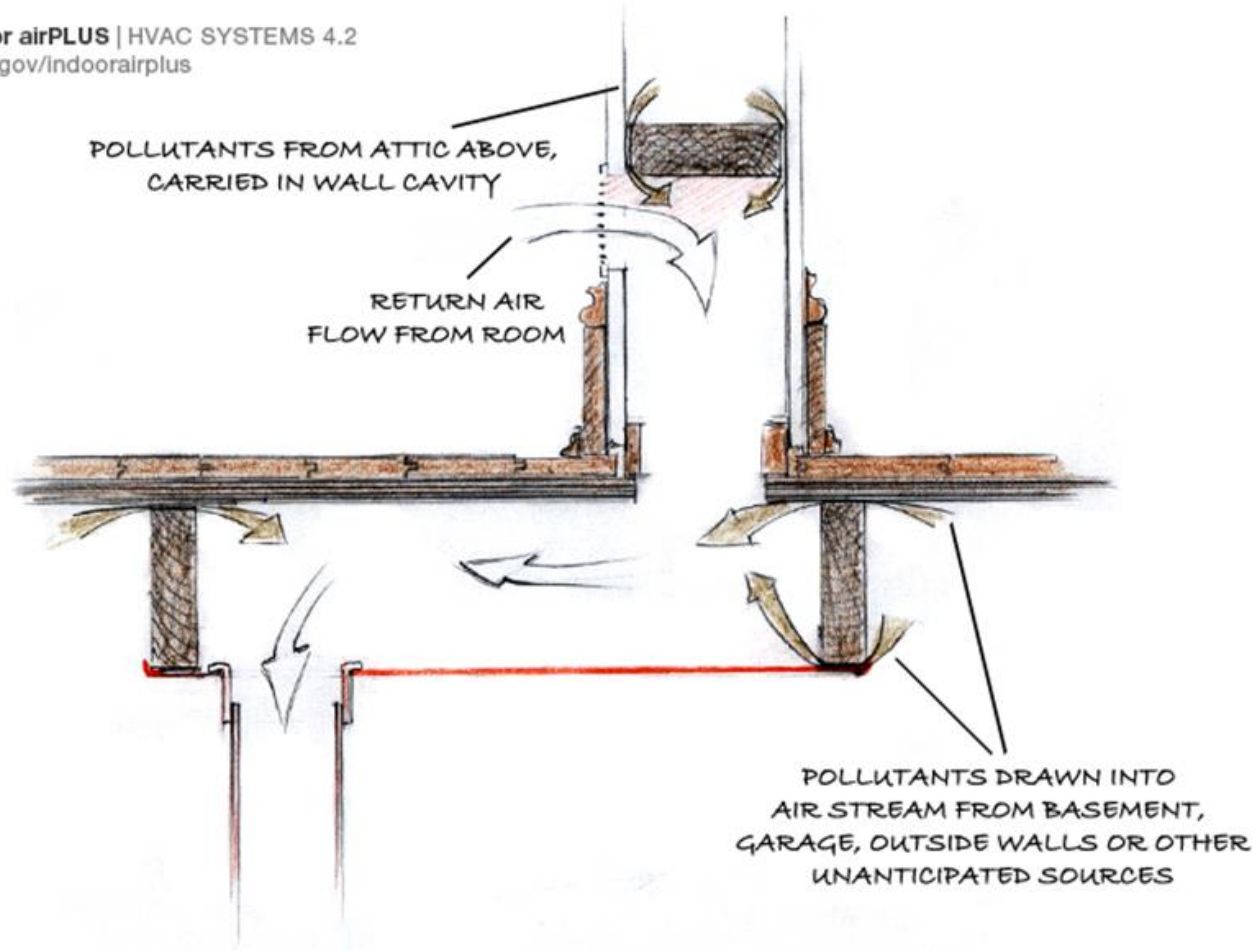
4.2 Duct System Design and Installation

COVERING DUCT OPENINGS DURING CONSTRUCTION

SEALING WITH MASTIC



BUILDING CAVITIES (E.G., PANNED JOISTS) SHALL NOT BE USED AS FORCED-AIR SUPPLIES OR RETURNS (1 OF 2)



BUILDING CAVITIES (E.G., PANNED JOISTS)
SHALL NOT BE USED AS FORCED AIR SUPPLIED OR RETURNS, 2/2

4.2 Duct System Design and Installation

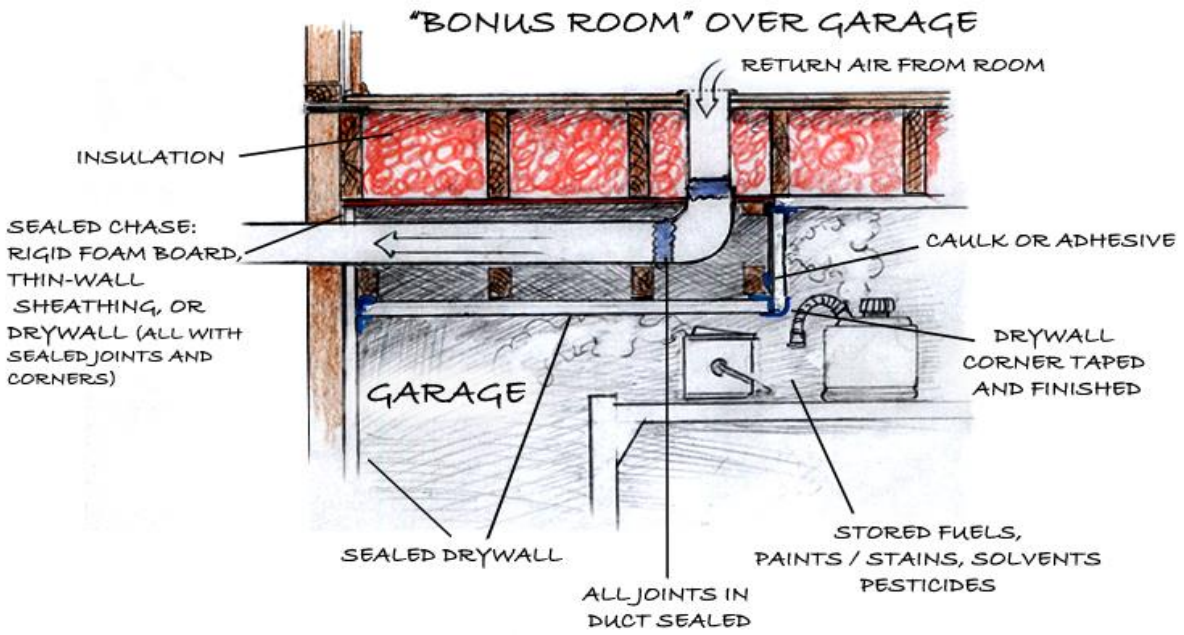
Verification

- 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

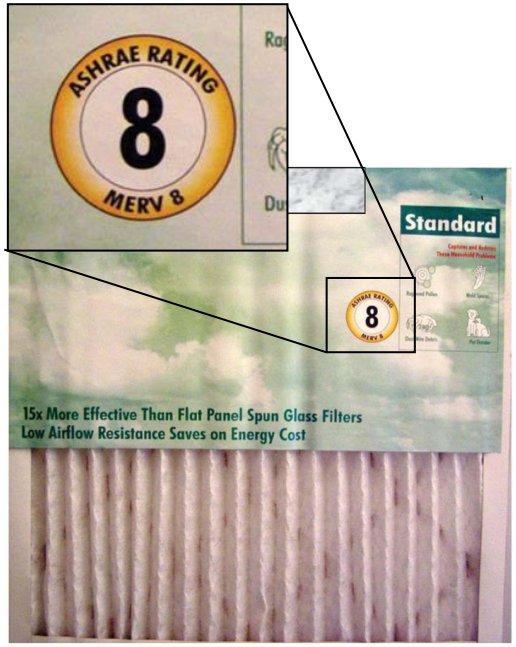
FRESH AIR DAMPER

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 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 about 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

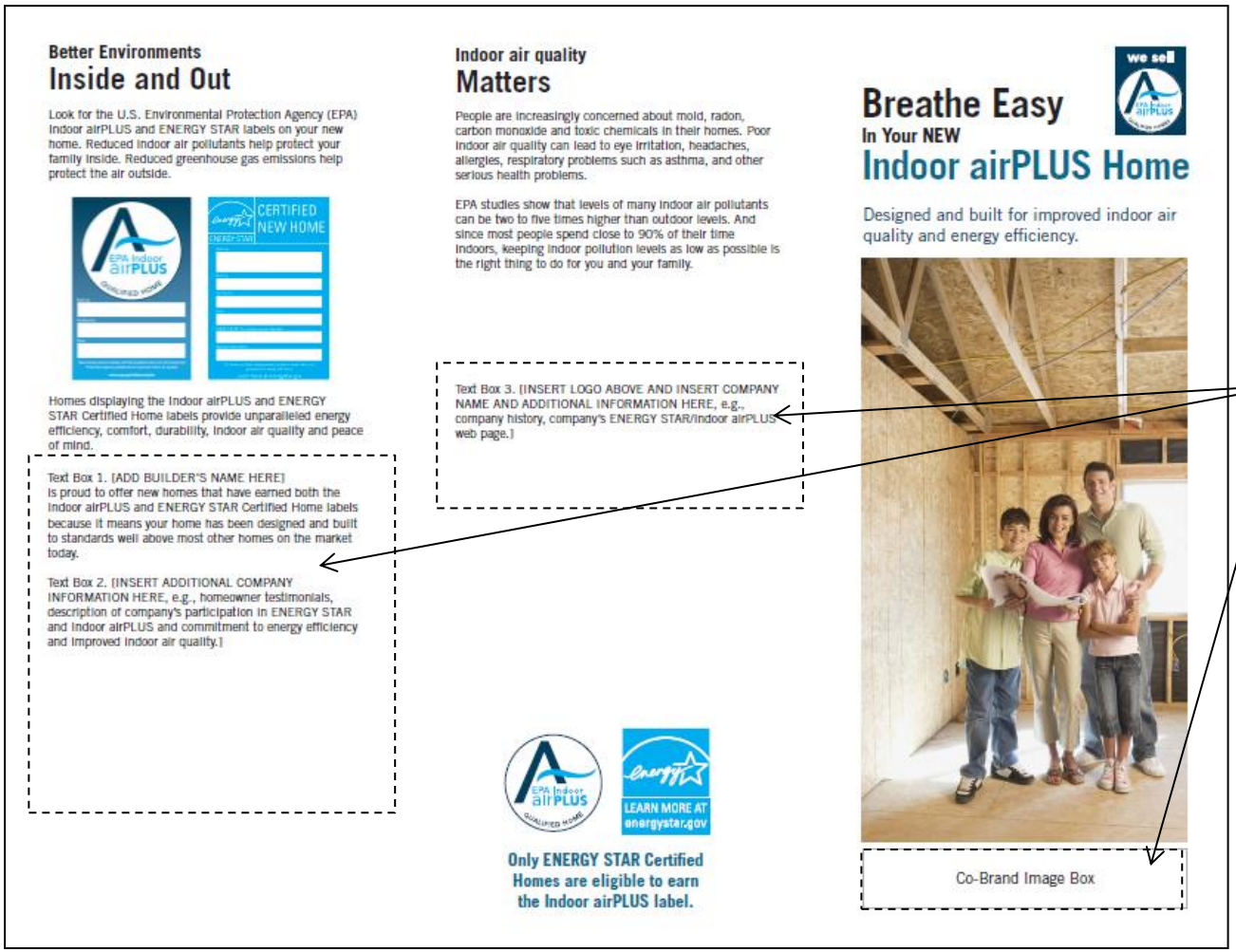
- Reduced exposure to mold and mildew
- Increased comfort
- Helps remove allergens, toxins, irritants and asthma triggers from the home
- House stays cleaner

Resources and Tools

Marketing and Technical Support for Partners

- Construction requirements
- Technical guidance
- Recorded webinars
- YouTube videos
- Builder and consumer resources
- Partner locator
- Website widgets
- Free brochures

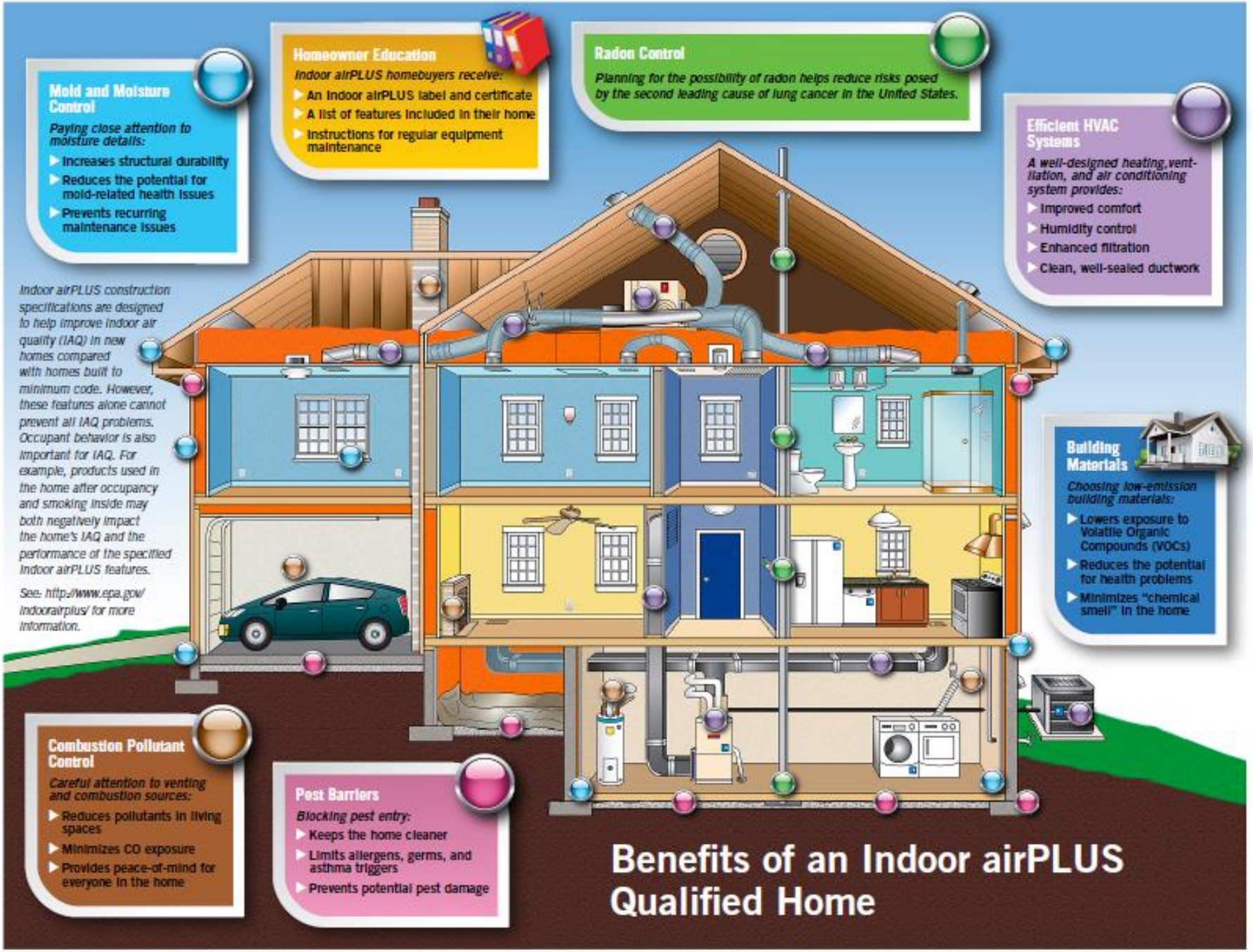
New Marketing Resources



Co-brandable Consumer Brochure

- Add company name, logo, and other info (testimonials, etc.)

Visit your My ENERGY STAR Account
www.energystar.gov/MESA


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

Indoor airPLUS Leader Awards

2014 Leader Award Winners

Raters:

- **ASERusa**
- **E3 Energy**
- **Integral Building & Design, Inc.**
- **Steven Winter Associates, Inc.**

Builders:

- **Foxwood Builders, Inc.**
- **Palo Duro Homes, Inc.**
- **C&B Construction**

http://www.epa.gov/indoorairplus/leader_awards

Also watch for DOE's Housing Innovation Awards (for ZERH partners)

- *To be announced at the 2014 EEBA Excellence in Building Conference, St. Louis, MO – Sept. 23, 2014*

Resources and Tools

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

https://basc.pnnl.gov/

Building America Solution Center

- Solution Center Home
- Help

FIND YOUR TOPIC BY:

- Building Components
- Guides A-Z
- ENERGY STAR Certified Homes
- Zero Energy Ready Home

FIND RESOURCES:

- References and Resources
- CAD Files
- Image Gallery
- Case Studies

FIND PUBLICATIONS:

- Building Science Publications

The Building America Solution Center provides access to expert information on hundreds of high-performance construction topics, including air sealing and insulation, HVAC components, windows, indoor air quality, and much more. Click on the links below to explore the Solution Center.

More IAQ resources coming soon! Please consider submitting images and content:

https://basc.pnnl.gov/criteria-submitting-content-building-america-solution-center

look for EPA Indoor airPLUS QUALIFIED HOMES

Indoor Air Quality (IAQ)

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