



VOLUME 16.

**BUILDING AMERICA BEST PRACTICES SERIES**



MIXED-HUMID CLIMATE

## 40% Whole-House Energy Savings in the Mixed-Humid Climate

PREPARED BY

Pacific Northwest National Laboratory  
& Oak Ridge National Laboratory

September 2011

MEASURE	Building America Recommendations	Builder #1	Builder #2	Builder #3
<b>INSULATION</b> (take a look at a house under construction before sheetrock is installed)				
Insulation installed behind tubs, showers, stairs, fireplaces, etc.	Yes			
Insulation fills entire cavities—no voids or compressed batts—Attic insulation level without gaps and covers entire attic floor	Yes			
Rim joists are insulated	Yes			
Rigid foam insulation applied under exterior siding or stucco	Yes			
<b>WINDOWS</b> (take a look at a house under construction before exterior siding is installed)				
ENERGY STAR qualified windows, doors, and skylights	Yes			
Windows flashed to help repel water	Yes			
<b>MOISTURE MANAGEMENT</b> (take a look at a house under construction before exterior siding is installed)				
Ground slopes away from house on all sides or drainage is addressed	Yes			
Housewrap, building paper, or rigid foam exterior insulation, taped at seams and caulked at edges, covers OSB walls in wood-framed houses	Yes			
Roof flashing in valleys, where walls and roofs intersect, and at other places where water may enter the house—the more complex the roof, the more flashing you should see. Diverter flashing is used where roofs touch walls to direct water away from wall and into gutter.	Yes			
Air gap between stucco, brick, or masonry cladding and housewrap	Yes			
Overhangs for shade and to direct water away from walls	Yes			
No polyethylene in interior side of wall assembly. No vinyl wallpaper on interior face of exterior walls.	Yes			
Trees planted ten feet from house, no overhanging branches	Yes			
Plantings 18 to 36 inches away from the foundation	Yes			
No wood or siding in direct contact with ground minimum 8 in. clearance	Yes			
<b>AIR BARRIERS</b>				
Follow ENERGY STAR Version 3.0 thermal boundary guidelines	Yes			
All penetrations through exterior walls sealed	Yes			
Careful sealing of sheetrock or exterior sheathing	Yes			
Recessed can lights rated for insulation contact and airtight (ICAT)	Yes			
Electrical boxes on exterior walls caulked or gasketed	Yes			
Holes into attic sealed	Yes			
Attic hatch weather-stripped and insulated	Yes			
Air leakage tested with blower door test	Yes			
Draft stops installed behind tubs, showers, stairs, and fireplaces, under kneewalls and cantilevered floors, and in floor joist bays spanning garages and living spaces	Yes			
Garage completely sealed from conditioned areas of house	Yes			
Sill plates gasketed or sealed	Yes			

not cover it or extend behind it. Foam seal or caulk all top plate penetrations and exterior wall penetrations.

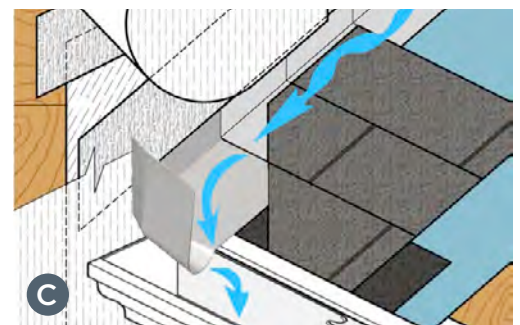
- Use pressure-treated lumber to frame out sub-jamb and spacers within window and door rough openings.
- As with other walls, penetrations to the exterior or through top and bottom plates should be foam sealed or caulked. Also air seal penetrations to garages and porches.
- Mud, tape, and caulk seams and corners of gypsum board and use sill sealer at top plates and bottom plates to control air leakage through the walls.
- When pouring the slab, take care to create a seat in the concrete to accept the block and seats in the concrete to act as drain pans where exterior doors and sliding doors will be located.

## Roof Assemblies

### Controlling Liquid Water in Roof Assemblies

Roof and wall assemblies must contain surfaces that will drain water in a continuous manner down and off the building. Water must have a path that will take it from its point of impact, around any elements, such as chimneys, windows, doors, and seams, all the way to the exterior ground, and away from the house. Consider implementing the following recommendations:

- Properly flash valleys and roof edges [2009 and 2012 IRC R703.8; R903.2].
- Size gutters and downspouts to accommodate anticipated storms. Show gutter sizes on elevations and specify sizes in construction documents.
- Provide downspout drainage to carry water at least 3 feet beyond the building.
- Use kick-out diverters properly integrated with flashing to direct water away from the side of the house [2009 and 2012 IRC R703.8, R903.2].
- In areas with potentially high winds and heavy rains, install 4-inch to 6-inch “peel and seal” self-adhering water-proofing strips over joints in roof decking before installing the roof underlayment and cover.
- Keep roof geometry simple. The more complex the roof—the more dormers, ridges, and valleys—the more likely the roof will leak.



(A) Deluging rains in the hot-humid climate can overwhelm gutters. Improper flashing can allow water into walls, causing significant damage. (B) Improvised deflectors that are improperly integrated into the wall flashing and gutter are rarely sized to handle the volume of water that can run off the roof in a large downpour and they may contribute to water entry into the wall. (C) To keep the water out, flashing should be integrated with the house wrap, siding, and shingles or roof tiles and (D) the diverter should be seamless and adequately sized to direct all of the water volume away from the wall and into the gutter. See Chapter 14 for details. (Photo Sources: A, C, D - DryFlekt Products, Inc., B - Steve Easley)



# Indoor airPLUS Verification Checklist

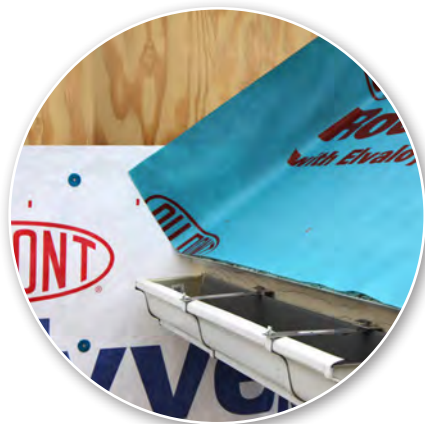


<b>Address or Div/Lot#:</b>					
<b>City/State/Zip:</b>			<b>Date:</b>		<b>Verified by</b>
Section	Requirements (see Indoor airPLUS Construction Specifications for details)	N/A	Builder	Rater	
Moisture Control	<b>Water-Managed Site and Foundation</b>				
	1.1	Site & foundation drainage: sloped grade, protected drain tile, & foundation floor drains	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1.2	Capillary break below concrete slabs & in crawlspaces (Exception - see specification)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1.3	Foundation wall damp-proofed or water-proofed (Except for homes without below-grade walls)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1.4	Basements/crawlspaces insulated & conditioned (Exceptions - see specification)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Water-Managed Wall Assemblies</b>				
	1.5	Continuous drainage plane behind exterior cladding, properly flashed to foundation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1.6	Window & door openings fully flashed	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Water-Managed Roof Assemblies</b>				
	1.7	Gutters/downspouts direct water a minimum of 5' from foundation (Except in dry climates)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1.8	<b>Fully flashed roof/wall intersections (step &amp; kick-out flashing) &amp; roof penetrations</b>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	1.9	Bituminous membrane installed at valleys & penetrations (Except in dry climates)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1.10	Ice flashing installed at eaves (Except in Climate Zones 1 - 4)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Interior Water Management</b>					
1.11	Moisture-resistant materials/protective systems installed (i.e., flooring, tub/shower backing, & piping)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
1.12	No vapor barriers installed on interior side of exterior walls with high condensation potential	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
1.13	No wet or water-damaged materials enclosed in building assemblies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Radon	2.1	Approved radon-resistant features installed (Exception - see specification)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.2	Two radon test kits & instructions/guidance for follow-up actions provided for buyer (Advisory-see specification)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Pests	3.1	Foundation joints & penetrations sealed, including air-tight sump covers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	3.2	Corrosion-proof rodent/bird screens installed at all openings that cannot be fully sealed (e.g., attic vents)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
HVAC	4.1	HVAC room loads calculated, documented; system design documented; coils matched	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4.2	Duct system design documented & properly installed OR duct system tested (check box if tested) <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4.3	No air handling equipment or ductwork installed in garage; continuous air barrier required in adjacent assemblies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4.4	Rooms pressure balanced (using transfer grills or jump ducts) as required OR tested (check box if tested) <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4.5	Whole house ventilation system installed to meet ASHRAE 62.2 requirements	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4.6	Local exhaust ventilation to outdoors installed for baths, kitchen, clothes dryers, central vacuum system, etc.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4.7	Central forced-air HVAC system(s) have minimum MERV 8 filter, no filter bypass, & no ozone generators	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4.8	Additional dehumidification system(s) or central HVAC dehumidification controls installed (In warm-humid climates only)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Combustion Pollutants	<b>Combustion Source Controls</b>				
	5.1	Gas heat direct vented; oil heat & water heaters power vented or direct vented (Exceptions - see specifications)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	5.2	Fireplaces/heating stoves vented outdoors & meet emissions/efficiency standards/restrictions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	5.3	Certified CO alarms installed in each sleeping zone (e.g., common hallway) according to NFPA 720	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	5.4	Smoking prohibited in common areas; outside smoking at least 25' from building openings (Multi-family homes only)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>Attached Garage Isolation</b>				
	5.5	Common walls/ceilings (house & garage) air-sealed before insulation installed; house doors gasketed & closer installed	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	5.6	Exhaust fan (minimum 70 cfm, rated for continuous use) installed in garage & vented to outdoors (controls optional)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Materials	6.1	Certified low-formaldehyde pressed wood materials used (i.e., plywood, OSB, MDF, cabinetry)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	6.2	Certified low-VOC or no-VOC interior paints & finishes used	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	6.3	Carpet, adhesives, & cushion qualify for CRI Green Label Plus or Green Label testing program	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Final	7.1	HVAC system & ductwork verified dry, clean, & properly installed	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	7.2	Home ventilated before occupancy OR initial ventilation instructions provided for buyer	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	7.3	Completed checklist & other required documentation provided for buyer	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Rater/Provider:</b>			<b>Builder:</b>		
<b>Company:</b>			<b>Company:</b>		
<b>Signature:</b>			<b>Signature:</b>		

## Wall-to-Roof Flashing

### Kick-Out Diverter Flashing Details – Housewrap Installed Over OSB or Plywood as Water-Resistive Barrier

Water runoff from rain storms can run along roof-wall intersections and spill over gutters to flow down exterior walls. If flashing is lacking or inadequate, this water runoff can get inside the wall and cause serious damage. Anywhere roof sections adjoin wall sections, side-wall flashing should be used to keep water from entering the walls and kick-out diverters should be used to direct the rain water into rain gutters where it can be carried down and away from the structure. The kick-out flashing should be seamless and sized (as shown in the photos below) to effectively manage large volumes of water run-off associated with torrential rains from a variety of roof pitches, with an appropriate expected service life to avoid premature failures. (Photos Source: DryFlekt Products, Inc.)



**STEP 1** Apply drip edge and roof underlayment over roof deck. Continue lapping up the sidewall and over the water-resistive barrier (in this case housewrap) a minimum of 6 inches.



**STEP 2** Install shingle starter strip at roof eave in accordance with roofing manufacturer's instructions.

- Place seamless one-piece of non-corrosive kick-out diverter flashing as the first piece of step flashing.
- Slide kick-out diverter up roof plane until the starter trough stops at the shingle starter strip.
- The diverter must be flat on the roof and flush to the sidewall.
- Fasten and seal diverter to the roof deck and starter strip. (Do not fasten to the sidewall.)



**STEP 3** Place first shingle and next section of sidewall flashing over the up-slope edge of diverter, lapping a minimum of 4 inches over diverter. (Sidewall flashing height requirement should be determined by design professional and local building codes.)



**STEP 4** Install remaining sidewall flashing, appropriate counter flashing, and shingles in accordance with manufacturer's instructions.



**STEP 5** Apply self-adhesive flashing over top of wall flashing, diverter, and housewrap.



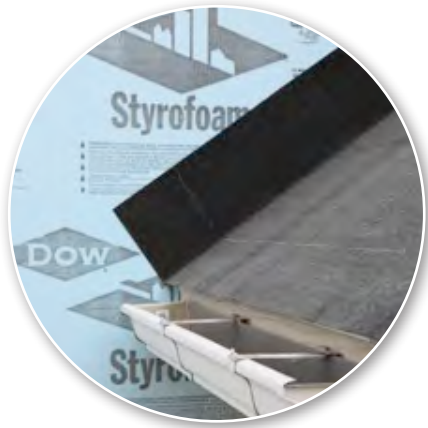
**STEP 6** Install house wrap; cut the house wrap to fit over the self-adhesive flashing and sidewall flashing.

**STEP 7** Apply siding over housewrap.

## Wall-to-Roof Flashing

### Kick-Out Diverter Flashing Details - Rigid Foam Insulation Installed as a Water-Resistive Barrier

Water runoff from rain storms can run along roof-wall intersections and spill over gutters to flow down exterior walls. If flashing is lacking or inadequate, this water runoff can get inside the wall and cause serious damage. Anywhere roof sections adjoin wall sections, side-wall flashing should be used to keep water from entering the walls and kick-out diverters should be used to direct the rain water into rain gutters where it can be carried down and away from the structure. The kick-out flashing should be seamless and sized (as shown in the photos below) to effectively manage large volumes of water run-off associated with torrential rains from a variety of roof pitches, with an appropriate expected service life to avoid premature failures. (Photos Source: DryFlekt Products, Inc.)

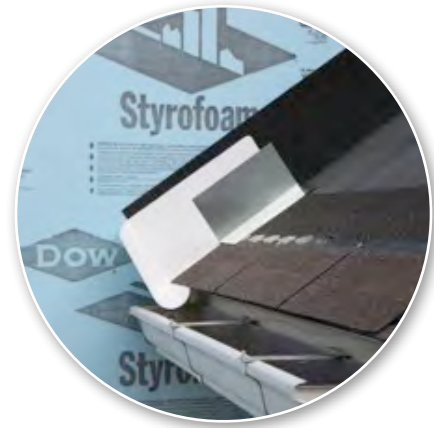


**STEP 1** Apply drip edge and roof underlayment over roof deck and continue lapping up the sidewall and over the water-resistive barrier (in this case rigid foam insulation) a minimum of 7 inches.



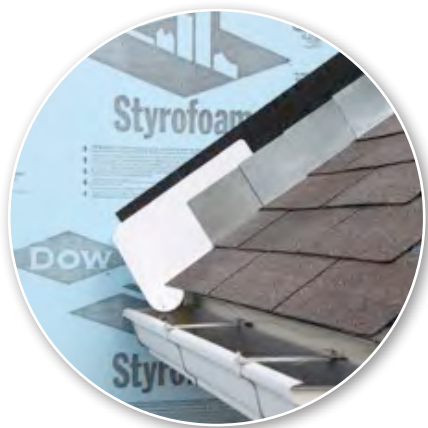
**STEP 2** Install shingle starter strip at roof eave in accordance with roofing manufacturer's instructions.

- Place seamless, one-piece, non-corrosive kick-out diverter flashing as the first piece of step flashing.
- Slide kick-out diverter up roof plane until the starter trough stops at the shingle starter strip.
- Diverter must be flat on the roof and flush to the sidewall.
- Fasten and seal diverter to the roof deck and starter strip. (Do not fasten to the sidewall.)



**STEP 3** Place first shingle and next section of sidewall flashing over up-slope edge of diverter, lapping a minimum of 4" over diverter.

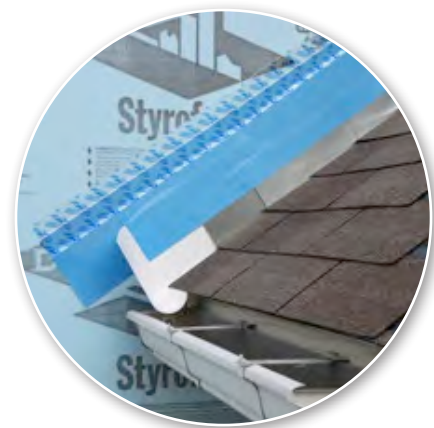
(Sidewall flashing height requirement should be determined by design professional and local building codes.)



**STEP 4** Install remaining sidewall flashing, appropriate counter flashing and shingles in accordance with manufacturer's instructions.



**STEP 5** Apply self adhesive flashing over top of wall flashing, diverter and rigid foam insulation.



**STEP 6** Apply construction tape over the self-adhered flashing.

**STEP 7** Apply siding over rigid foam insulation.