Scope

Install flashing at bottom of all exterior walls and properly integrate the flashing with other wall water management details to direct water down and out of the wall.

- Install flashing under the bottom edge of the house wrap or other weather-resistant barrier shingle fashion to direct water out of the wall.

- Stucco cladding – install self-adhesive flashing behind the weep screed, a perforated metal strip at the base of the exterior walls, at the height above grade specified by the local building code. Install the water-resistant barrier to overlap the top edge of the weep screed. Install the lathe and stucco to the first bend in the weep screed.

- Brick veneer – install metal or flexible through-the-wall flashing that starts behind the bottom edge of the weather-resistant barrier and extends down and out across the support ledge then hangs down. Ensure that weep holes are included in the bottom course of brick to allow water to drip out and down the flashing. Install in brick walls at the base of walls, above all window and door lintels, and above shelf angles.

Figure 1. Install flashing at the bottom edge of the exterior above-grade wall and overlap with weather-resistant barrier.
Figure 2. Install weep holes at the bottom course of all brick walls.

Figure 3. Install a weep screed at the base of stucco walls with an adhesive flashing behind it and house wrap and lathe overlapped over the top edge of the weep screed.

See the Compliance Tab for related codes and standards requirements, and criteria to meet national programs such as DOE's Zero Energy Ready Home program, ENERGY STAR Certified Homes, and Indoor airPLUS.
Description

Flashing at the bottom of exterior walls needs to be integrated into a continuous drainage plane on the exterior wall. The goal is to create a wall system that can manage the water that will inevitably get behind any cladding system.

Principles of a Water Managed Wall System

Water leaking through exterior cladding assemblies is a common cause of construction defects and call-backs.

![Figure 1 - Common callback: This damage was caused by a leak at the base of the wall cladding that did not include proper through-wall flashing.](image)

Typically, these wall leaks are caused by missing flashings or poorly executed flashing details at the following:

- roof-to-wall intersections
- penetrations
- windows and doors
- transitions between different claddings when more than one cladding is used at the bottoms of exterior walls where cladding systems interface with the foundation.

The key to eliminating costly leaks is more than just applying a piece of flashing. You need to create a functional wall assembly that:

- **Deflects** water away from sheathing, framing and floor-to-foundation intersections.
- **Drains** water as fast and freely as possible to prevent water from being trapped and absorbed by building components.
- **Dries**. Select building materials that allow the wall to dry out when it gets wet, and avoid materials that have the ability to trap moisture (BSC 2007).

Continuous Drainage Plane

Drainable wall assemblies integrate a weather-resistant barrier and flashing to properly drain water away from building components. The specific materials and installation methods depend on the cladding used on the building. House wrap and flashing must be properly integrated to create a continuous drainage plane. Note in Figure 2 that the flashing at the bottom of the wall is just one of a number of wall details that work in concert with each other to ensure water drains down and away from the building (Straube 2007).
Figure 2 - From the roof to the foundation, wall flashings are integrated into a continuous drainage plane to divert water.

Installation Sequence

A continuous drainage plane is typically created using a weather-resistive barrier (WRB), such as building paper or housewrap. To work effectively, the weather-resistive barrier must be properly "shingled." Shingling is a term that describes the installation sequence that will allow water to drain away from the wall.
Figure 3 shows how the layers of the weather-resistant barrier must overlap to divert water out and away from the structure. In the sequence of construction, the flashing would need to be installed first. The bottom layer of building paper would be installed next, overlapping the vertical leg of the flashing. The top layer of building paper would be installed last (BSC 2007).

Rain screen wall systems also provide an air space between the wrap and the cladding. This air space helps reduce water problems in several ways.

1. The larger space can create faster, unobstructed drainage.
2. The space creates a capillary break to prevent water from wicking into building materials.
3. The space allows for additional air movement to facilitate drying.
4. The space can provide pressure moderation and help reduce pressure differentials that can help draw water into openings in the cladding.
5. Helps prevent water vapor from the cladding from being driven into the wall assembly.

The air space varies depending on the cladding material. Wall venting behind brick and stone veneers is especially important. Under the right conditions, energy from the sun can push vapor through wet brick with the force of a steam boiler. A ventilation gap behind brick helps to dissipate this vapor before it is injected into the framed wall cavity. The gap should be 1 or more inches behind brick or stone veneer, 3/4 inch behind stucco, and 1/16 inch behind lap siding (Wrinkled house wrap will provide this 1/16-inch gap.)

How to Construct a Drainable Wall Assembly with Wood or Fiber-Cement Sided Walls

1. Base flashing. Start by installing a metal or vinyl base flashing first. This piece should be applied directly to the wall sheathing using roofing nails. When more than one length is needed to span across the bottom of a wall, overlap pieces at least 8 inches. The flashing must include a drip-edge to direct any water that runs down the drainage plane away from the bottom of the wall.

2. Weather-resistant barrier. Next, a weather-resistant barrier, such as building paper or house wrap, is applied to the wall, overlapping the base flashing. The example pictured in Figure 4 is a “drain wrap,” which has a texture to it to facilitate drainage after the siding is applied over it. You don’t need a drain wrap to create a drainable wall assembly, but the texture drains water faster than conventional smooth house wraps. There are several types of drain wrap: one type has a wrinkled surface; one type has plastic bumps that create a space between the wrap and the cladding (Smegal and Lstiburek 2012).
3. 8-inch minimum between siding and grade. To prevent splash back from the roofline soaking the base of the wall, the bottom edge of the base flashing should be at least 8 inches above grade. This is a design detail that must be worked out before the foundation is poured. The grade must be sloped on all sides of the building so the water continues to drain away from the building. A 5% slope is recommended. This is a 5-inch drop per 100 feet, or about 5/8-inch per foot (Straube 2007).

How to Construct a Drainable Wall Assembly with Stucco Clad Walls

Stucco is porous and will always crack. This is true even when installed perfectly. It is brittle, and cracking is in its nature. However, while these shortfalls will lead to water getting through the surface, the water can be managed. The key is to create a good drainage plane behind the stucco that drains to a weep system, allowing the water to flow out and away from the building.

1. Self-adhesive flashing. When the weep screed attaches to plywood, OSB, or another wood-based framing material, a self-adhesive flashing membrane is needed first to protect the wood from water draining through the perforated screed (EPA 2015).

2. Weep screed. Next, a weep screed is installed. The bottom edge of this piece of flashing should extend onto the foundation. The size of the screed will depend on the stucco thickness, with traditional three-coat stucco requiring a deeper profile than the screed needed for a one coat system. On an exterior insulation and finish (EIF) system, this flashing piece is called a weep channel, and it holds the bottom edge of the foam. It is perforated and works in principle just like a weep screed (EPA 2015).

3. Two-layer weather resistive barrier. Most building codes require two-layers of building paper (or another type of weather-resistive barrier) beneath the stucco. The first layer (installed against the sheathing) serves as the drainage plane and protects the wall sheathing from water. The second layer works as a bond breaker. Wet stucco tends to adhere to building paper and house wrap. Water absorbed by the stucco will wick right through this bond breaking layer, but will drain down the wall between the two layers. Both layers should overlap the top edge of the weep screed (Lstiburek 2003).

4. Lath. On wood framing, wire lath must be installed with the long dimension running perpendicular to the wall studs. Best practice calls for securing lath with furring nails, which place the lath in the center of the scratch coat (Note: Using paper-backed lath over a single-layer of house wrap or building paper will work as well as a two-layer weather resistive barrier and will save time) (DeKorne 2006).
How to Construct a Drainable Wall Assembly with a Rain Screen Air Gap for Wood or Fiber-Cement Siding

Best practice with any wood or fiber-cement siding calls for building a rain screen assembly. This technique uses all the same water management details of a drainable wall assembly, but adds an air space behind the siding. This space creates a capillary break, which prevents water that wicks through the siding from being absorbed into the water-resistant barrier. The air space also allows air to flow freely behind the siding, which increases the wall’s ability to dry.

1. Base flashing. The wall system begins with flashing at the bottom of the wall, which collects water that drains down the wall and kicks it out at the base. Metal or PVC flashing can be used. It should have a drip edge that hangs below the sill plate, with the bottom edge at least 8 inches above grade (EPA 2015).

2. Weather-resistant barrier. After the flashing, a weather-resistant barrier (WRB), such as building paper or a house wrap is installed to create a drainage plane. The first course of the WRB needs to overlap the vertical leg of the base flashing. Subsequent courses of the WRB must overlap the course below (EPA 2015).

3. Furring. The air space is created by installing furring strips (vertical pieces of wood or plastic) spaced every 16-24 inches over the weather-resistant barrier. These need to be at least 3/8 inches thick. They can be ripped out of plywood or purchased precut from a lumberyard, and nailed every 12-16 inches with 5d galvanized nails (Hanley-Wood 2007).

4. Insect screen. To block the entry of insects, install nylon screening. Tuck the screening behind the furring strips, wrap it around the ends of the strips, and pin it in place with the siding starter strip. Nylon is recommended, but other types of screening can be used, as long as it is an open mesh that will not block the free flow of air. Metal will rust and is not recommended (EPA 2015).
How to Construct a Drainable Wall Assembly with a Rain Screen Air Gap for Brick Veneer Siding

Properly detailed brick veneer functions like a rain screen. The key is making sure there is an unobstructed path for water to flow out at the bottom of the wall. This path starts with the airspace behind the brick. Water freely flows down through this space, gets collected by through-wall flashing at the bottom of the wall, and drains out through weep holes.

1. Through-wall flashing. The first step to detailing the base of a brick-veneer wall is to install a through-wall flashing, which extends down the sheathing and out across the support ledge (often a concrete extension of the foundation, but may also be formed with angle-iron).

Through-wall flashing can be made with metal, but is usually formed with a flexible rubber-based membrane, such as the one shown in Figure 8 (Hanley-Wood 2007).
2. **Weather-resistant barrier.** Next, a weather-resistant barrier, such as building paper, must be applied over the framed wall assembly. The courses of the weather-resistant barrier must be applied "shingle fashion," with the lowest course applied first, overlapping the vertical leg of the through-wall flashing. The upper courses are installed afterwards, overlapping each lower course ([EPA 2011](#)).

3. **Air space.** The brick must be installed with a 1-inch air space behind it to allow water that seeps into the brick to freely drain. The illustration above shows a mortar mesh installed in the air space at the base of wall. This helps to stop mortar droppings from clogging the weep holes ([EPA 2011](#)).

4. **Weep holes.** Water that collects on the through-wall flashing must be able to drain out through weep holes, which are formed by an "open" head joint (as shown in the illustration above), or with rope inserted into the mortar joint (as shown in the photo below). In this illustration the open head joints have been filled with an open-weave mesh. This is a good idea for keeping mud wasps from building their nests in the weep holes, and to prevent other obstructions from blocking the free flow of water ([EPA 2012](#)).
Figure 9 - Rope is inserted in the head joist between the bricks in the lowest course of bricks to allow water to weep out of the base of the wall assembly.
Ensuring Success

Builders and subcontractors should follow a protocol for water management details in exterior walls such as the ENERGY STAR Qualified Homes Water Management System Builder Checklist.

The project supervisor should inspect for flashing at the base of walls and at transitions between sidings before the siding is installed. This inspection should confirm that the weather-resistive barrier (WRB) overlaps the base flashings (EPA 2011).

Success with stucco

For wood-framed structures, hang the drywall before the lath and scratch coat are applied. Otherwise, the weight of the drywall will stress the wood framing, causing early settlement cracks, which can be acute if the drywall is hung before the scratch coat has had a chance to cure (DeKorne 2006).
Climate

The chief climate factor is exposure to rainfall. Buildings in regions with more rainfall are subject to increased incidence of water damage.

Drainable wall assemblies are recommended in all exposure regions. Rain-screen wall systems are considered best-practice upgrades in all exposure regions to ensure the long-term durability of building assemblies, but are especially recommended in High and Extreme exposure regions, as shown on the map below (*BSC 2004*).

![Figure 1 - Average Annual Precipitation Map](image-url)
Training

Right and Wrong Images

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Compliance

The Compliance tab contains both program and code information. Code language is excerpted and summarized below. For exact code language, refer to the applicable code, which may require purchase from the publisher. While we continually update our database, links may have changed since posting. Please contact our webmaster if you find broken links.

ENERGY STAR Certified Homes, Version 3/3.1 (Rev. 09)

Water Management System Builder Requirements

2. Water-Managed Wall Assembly.
2.1 Flashing at bottom of exterior walls with weep holes included for masonry veneer and weep screed for stucco cladding systems, or equivalent drainage system.\(^9\)

Footnote 9) These Items not required for existing structural masonry walls (e.g., in a home undergoing a gut rehabilitation). Note this exemption does not extend to existing wall assemblies with masonry veneers.

Please see the ENERGY STAR Certified Homes Implementation Timeline for the program version and revision currently applicable in your state.

DOE Zero Energy Ready Home (Revision 07)

Exhibit 1 Mandatory Requirements.
Exhibit 1, Item 1) Certified under the ENERGY STAR Qualified Homes Program or the ENERGY STAR Multifamily New Construction Program.

2009 IRC

Section R703.6.2.1 Weep screeds. A minimum 0.019-inch (No. 26 galvanized sheet gage), corrosion-resistant weep screed or plastic weep screed, with a minimum vertical attachment flange of 31/2 inches must be provided at or below the foundation plate line on exterior stud walls per ASTM C 926. It must be placed a minimum of 4 inches above the earth or 2 inches above paved areas and must allow trapped water to drain to the exterior. The weather-resistant barrier must lap the attachment flange, and the exterior lath must cover and end on the weep screed attachment flange. Section R703.7.5 Flashing. Flashing must be located beneath the first course of masonry above finished ground level above the foundation wall or slab and at other points of support, including structural floors, shelf angles and lintels when masonry veneers are designed per Section R703.7. Section R703.7.6 Weepholes. Weepholes must be provided in the outside wythe of masonry walls at maximum spacing of 33 inches on center and must be located directly above the flashing.

2012 IRC

Section R703.6.2.1 Weep screeds. A minimum 0.019-inch (No. 26 galvanized sheet gage), corrosion-resistant weep screed or plastic weep screed, with a minimum vertical attachment flange of 31/2 inches must be provided at or below the foundation plate line on exterior stud walls per ASTM C 926. It must be placed a minimum of 4 inches above the earth or 2 inches above paved areas and must allow trapped water to drain to the exterior. The weather-resistant barrier must lap the attachment flange, and the exterior lath must cover and end on the weep screed attachment flange. Section R703.7.5 Flashing. Flashing must be located beneath the first course of masonry above finished ground level above the foundation wall or slab and at other points of support, including structural floors, shelf angles and lintels when masonry veneers are designed per Section R703.7. Section R703.7.6 Weepholes. Weepholes must be provided in the outside wythe of masonry walls at maximum spacing of 33 inches on center and must be located directly above the flashing.

2015 and 2018 IRC

Section R703.7.2.1 Weep screeds. A minimum 0.019-inch (No. 26 galvanized sheet gage), corrosion-resistant weep screed or plastic weep screed, with a minimum vertical attachment flange of 3.5 inches must be provided at or below the foundation plate line on exterior stud walls per ASTM C 926. It must be placed a minimum of 4 inches above the earth or 2 inches above paved areas and must allow trapped water to drain to the exterior. The weather-resistant barrier must lap the attachment flange, and the exterior lath must cover and end on the weep screed attachment flange.

Section R703.8.5 Flashing. Flashing must be located beneath the first course of masonry above the finished ground level above the foundation wall or slab and at other points of support, including structural floors, shelf angles, and lintels when masonry veneers are designed per Section R703.8.

Section R703.8.6 Weepholes. Weepholes must be provided in the outside wythe of masonry walls at maximum spacing of 33 inches on center and must be located directly above the flashing.


Section N1101.3 (Section N1107.1.1 in 2015 and 2018 IRC). Additions, alterations, renovations, or repairs shall conform to the provisions of this code, without requiring the unaltered portions of the existing building to comply with this code. (See code for additional requirements and exceptions.)
Appendix J regulates the repair, renovation, alteration, and reconstruction of existing buildings and is intended to encourage their continued safe use.
Access to some references may require purchase from the publisher. While we continually update our database, links may have changed since posting. Please contact our webmaster if you find broken links.

References and Resources*

1. 2009 IRC - International Residential Code for One and Two Family Dwellings  
   Author(s): International Code Council  
   Organization(s): ICC  
   Publication Date: January, 2009  
   Code for residential buildings that creates minimum regulations for one- and two-family dwellings of three stories or less. It brings together all building, plumbing, mechanical, fuel gas, energy and electrical provisions for one- and two-family residences.

2. 2012 IRC - International Residential Code for One and Two Family Dwellings  
   Author(s): International Code Council  
   Organization(s): ICC  
   Publication Date: January, 2012  
   Code for residential buildings that creates minimum regulations for one- and two-family dwellings of three stories or less. It brings together all building, plumbing, mechanical, fuel gas, energy and electrical provisions for one- and two-family residences.

3. 2015 IRC - International Residential Code for One and Two Family Dwellings  
   Author(s): International Code Council  
   Organization(s): ICC  
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4. 2018 IRC - International Residential Code for One and Two Family Dwellings  
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5. DOE Zero Energy Ready Home National Program Requirements (Rev. 07)  
   Author(s): U.S. Department of Energy  
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   Standard requirements for DOE's Zero Energy Ready Home national program certification.

6. ENERGY STAR Certified Homes, Version 3/3.1 (Rev. 09) National Program Requirements  
   Author(s): U.S. Environmental Protection Agency  
   Organization(s): EPA  
   Publication Date: September, 2018  
   Webpage with links to documents providing the program requirements and checklists for ENERGY STAR Certified Homes (Ver. 3/3.1, Rev. 09).

7. EPA Indoor airPLUS Construction Specifications, Version 1 (Rev. 04)  
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   Organization(s): EPA  
   Publication Date: February, 2018  
   Website providing the technical specifications and related documents for home builders, subcontractors, architects, and other housing professionals interested in certifying a home to the EPA's Indoor airPLUS program requirements.

8.
9. Rain Control in Buildings
Author(s): Straube
Organization(s): Building Science Corporation
Publication Date: October, 2006
Document covering basic moisture control principles in the design of above-grade building enclosures; driving rain as a moisture load on walls; a classification system of the various rain control strategies available for walls; and good design practises for walls.

10. Stucco that Works
Author(s): DeKorne
Organization(s): DeKorne
Publication Date: May, 2006
Information sheet describing correct application of stucco.

11. The JLC Guide to Moisture Control
Author(s): Hanley-Wood
Organization(s): Journal of Light Construction
A field guide with residential construction best practices.

12. Water Managed Wall Systems
Author(s): Lstiburek
Organization(s): Building Science Corporation
Publication Date: March, 2003
Document outlining a well-detailed drainage plane and flashings.

13. Water Management Details for Residential Building (Housewraps/Flashing/Windows)
Author(s): Building Science Corporation
Publication Date: November, 2007
Document providing guidance on water management concepts and applications.

14. Water Management of Noninsulating and Insulating Sheathings
Author(s): Smegal, Lstiburek
Organization(s): Building Science Corporation
Publication Date: April, 2012
Report summarizing current research, summarizes issues that have been experienced with current best practices, and recommends ways in which the best practices can be improved for water managing sheathings.

15. Water Management System Builder Checklist Guide
Author(s): U.S. Environmental Protection Agency
Publication Date: February, 2011
Guide describing details that serve as a visual reference for each of the line items in the Water Management System Builder Checklist.

*Publication dates are shown for formal documents. Dates are not shown for non-dated media. Access dates for referenced, non-dated media, such as web sites, are shown in the measure guide text.

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