

Materials & Methods for Flashing Penetrations

TILE ROOFING



Courtesy NextEnergy Solar

It has never been easy to mount PV or solar water heating collector-racking systems to a tile roof. Most installers who are not familiar with tile roofs cringe at the thought of the labor involved in waterproofing tile roof penetrations. When tile-integrated PV systems are not an option, tile roofs must be penetrated and flashed according to local and international codes. The good news is that as the industry grows, new products and installation methods are becoming

low-profile interlocking channeled tile to traditional cap-and-barrel Spanish tile. Most flat-tile roofs consist of cap-and-pan interlocking tiles with the cap on the right and the pan on the left of the tile, allowing the tile courses to interlock. Some common flat and curved tile manufacturers include Eagle, Hanson, Ludowici and MonierLifetile.

In addition to standard tile roofing products, there are slate roofs and other products such as Cedarlite, a concrete

SYSTEMS

By Johan Alfsen

available that allow installers to more quickly and easily apply appropriate, long-term solutions on the roof.

The key to being successful when working with tile roofs is to think and act like a roofer—to not only follow codes and best practices, but also know the materials. While most composition or asphalt shingle roofs share a similar anatomy and are waterproofed at the top layer, tile roofs have significant variation in their waterproofing systems. In North America, tile roofs were generally installed using the European method of waterproofing at the top tile level without use of an underlayment. In 1986, as a result of chronic roof leaks due in part to poor flashing methods, the Uniform Building Code (UBC) began requiring an underlayment to be installed over the decking of all tile roofs (UBC Table 15-D-1 and 15-D-2). Tiles provide the first layer of weather protection, but the flashing and underlayment is the final barrier when wind-driven rain, water and moisture infiltrate the roof system.

It is important to understand how these waterproofing systems work and how to apply the appropriate mounting and flashing solutions to a specific tile roofing system. While there are many types of tile and slate roofs with different waterproofing systems, here I focus on the method of double-flashing standoffs on flat and curved tile roofs. Before installing solar on any roof, it is best to review the roof manufacturer's installation instructions and specifications to determine how to best waterproof your penetrations.

TILE ROOFING TYPES

There are many different types of tile roofs. Interlocking flat-tile and curved tile that are typically made of either clay or concrete are the most commonly found types in North America today. Concrete tiles are made from a mixture of Portland cement, sand, aggregate, polymers and a little water. Clay tiles are often glazed and fired ceramic. Curved tile roofs vary in style, typically made from high- and

tile that looks like wood shake manufactured by Monier-Lifetile. DaVinci Roofscapes and EcoStar both manufacture synthetic slate and shake products that are made from recycled rubber and plastics. These materials may use underlayment waterproofing methods that are similar to standard tile roofing products, but they can be challenging to work with due to the manufacturer's installation specifications.

You might encounter unusual tiles that are hard to find or are no longer being manufactured. In these cases, it is important to follow manufacturer instructions or work with an experienced roofer who is familiar with the material and associated best practices. Someone familiar with the product may know where replacement tiles can be found in local roofing bone yards, for example.

UNDERLAYMENT TYPES

Underlayments are important in weatherproofing tile roofs. The most common underlayments consist of asphalt felt, synthetic polypropylene or a modified bitumen membrane, but material and installation specifics can vary greatly due to geography and local building codes.

Most tile roofs use number 15 or number 30 felt paper as underlayment. In areas with high wind zones, the underlayment and tiles typically need to be adhered to the roof in order to withstand wind speeds of up to 150 mph. In hurricane-prone Florida, for instance, underlayments commonly consist of a modified bitumen product that adheres to the roof decking. Tiles may also be adhered to the roof with cement mortar or polyurethane foam.

In some areas of the US, ice-dam protection membranes and other peel-and-stick adhesives were used as underlayments in the past. However, newer underlayment materials, such as synthetic polypropylene and single-ply modified bitumen products, are becoming more popular. These underlayments vary in application, so you should thoroughly research

them before applying underlayment flashing for PV racking standoffs. It is critical to follow the manufacturers' guidelines and specifications. Single- and double-layer felt underlayments can be easy to work with, but adhesive underlayments may require more sophisticated equipment and the use of torches or hot tar. For example, many peel-and-stick underlayments require an adhesive flashing to be applied with the underlayment; and other mop- or torch-down underlayments require labor-intensive roofing practices that must be performed by a professional roofer.

STANDARDS FOR BEST PRACTICES

Rack-mounting products such as tile hooks are common, but ultimately, these products rely on sealant at the underlayment level of the tile roof. The National Roofing Contractors Association (NRCA), the Tile Roofing Institute (TRI) and the Western States Roofing Contractors Association (WSRCA) provide industry best practices for tile roof installations. In the past, solar mounting systems were considered "roof attachments." The NRCA now classifies them as "roof penetrations" and suggests that all solar-mounting penetrations be flashed appropriately.

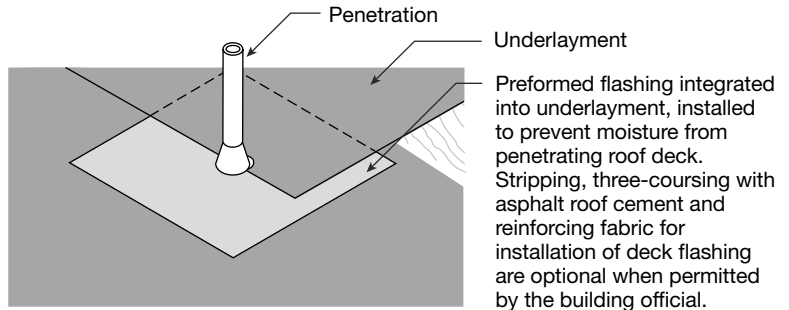
Although some building departments may not require double flashing, the NRCA, TRI, WSRCA, as well as roofers and many PV system installers see it as the best practice for waterproofing tile-roof penetrations. *The NRCA Roofing Manual: Steep-Slope Roof Systems-2009* includes specific directions for flashing methods for vent pipes on tile roofs. Standoff flashing approaches should follow similar guidelines. One method suggests using a primary flashing underneath the tiles to be waterproofed in conjunction with the underlayment, as well as a secondary flashing at the top tile level. *The Concrete and Clay Roof Tile Installation Manual for Moderate Climate Regions*, written by the TRI and WSRCA, also recommends this method (see Figure 1).

DOUBLE-FLASHING APPROACHES

The basic concept of double-flashing penetrations on a tile roof is to apply a primary flashing underneath the tiles and a secondary flashing, typically aluminum or lead, at the top tile level. Here I look at two examples of the techniques.

Sungevity is a California-based integrator with a leasing program that allows homeowners to purchase the PV system output rather than the system. The system itself is owned and maintained by Sungevity. To ensure high quality and performance, and to minimize the potential liability of water damage, Sungevity has developed a list of approved flashing

Step 1: Deck flashing



Step 2: Tile flashing

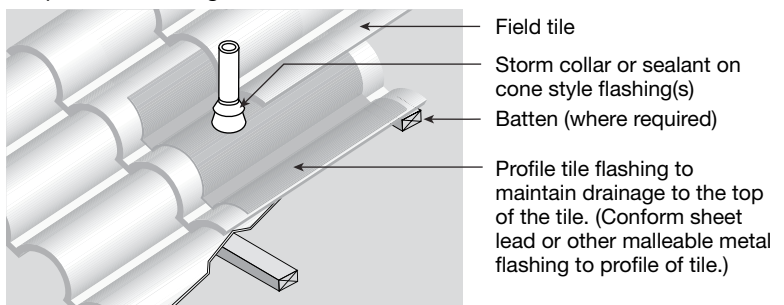


Figure 1 *The Concrete and Clay Roof Tile Installation Manual For Moderate Climate Regions* includes best practices for flashing roof penetrations for tile-roof applications as shown in this two-step illustration. Note that all penetrations should be located so as not to impede flashings at roof transitions.

products for tile-roof applications that comply with its strict installation guidelines.

Sungevity employs tile-mount double-flashing kits from Quick Mount PV that are based on one of the NRCA- and TRI-recommended methods of double flashing. These kits consist of a primary peel-and-stick butyl flashing designed to interlay into the felt underlayment, and which is followed by a secondary aluminum flashing on the top tile level (see Figures 2a and 2b, p. 66). The primary flashing is installed over a layer of felt paper and overlapped by the top layer of felt underlayment, similar to the approach shown in Figure 1. This provides a shingle-like lapping system that allows water to shed down the roof underlayment. The tile-level flashing provides a top layer of protection against direct elements such as rain, hail and long-term UV exposure.

Arizona-based American Solar Electric utilizes a similar but slightly different approach. This integrator uses galvanized flashing instead of peel-and-stick as the primary flashing. This primary flashing is installed underneath the tiles and over the underlayment. The primary flashing is then sealed using the three-course method listed in

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Figure 2a and 2b To meet one of the NRCA- and TRI-recommended methods of double flashing, the Quick Mount PV double-flashing kit consists of a primary peel-and-stick butyl flashing designed to interlay into the felt underlayment. A secondary preformed aluminum Flat Tile Mount flashing is applied at the top tile level.

the TRI manual (see Figure 3, p. 68). This system consists of a layer of approved mastic or roofing cement, a layer of mesh and another layer of mastic. Most building departments that require double flashing on tile roofs recognize this method.

RETROFIT APPLICATIONS

Poorly installed tile roofs can present problems for solar installers who may become vulnerable to liability issues on the roof after their job is complete. Many mistakes can be made when installing a tile roof. Proper batten and underlayment installation is key to allow complete drainage to keep the subroof clear, because concrete and clay deposits collect over the years underneath tiles. Many valleys and eaves

have been known to leak due to improper underlayment and batten installation—and damage from water intrusion may not become noticeable until it becomes severe. It is extremely important for solar installers to partner with a reputable roofing contractor who can verify the integrity of the existing roofing system prior to the solar installation. Although the NRCA and TRI manuals provide quality-assurance standards, they are mostly based on new roof applications. However, most solar installations are retrofit applications. Layering flashing into the underlayment on a new roof that is being constructed can be simple, but extra steps may be needed when a flashing must be retrofitted into existing underlayment. For example, on a retrofit application your standoff and primary flashing may not fall in a position that is close to the overlap of felt paper, making it difficult to achieve shingle-like layering between the primary flashing and underlayment. The method that is used to deal with this situation is called *bibbing*. When the overlapping drip edge of the felt paper ends in the tile course above the penetration, the installer can use a separate piece of felt paper to fit under the battens and overlapping felt, CONTINUED ON PAGE 68

The Importance of Properly Flashed Roof Penetrations

Anyone who has been in the solar industry longer than 5 years has seen dramatic changes and improvements in technology and installation practices. Five years ago, few solar installers paid sufficient attention to roof penetrations and simply relied on the classic L-bracket fastened directly into the roof with sealant as the only weather protection. Tony Diaz, a California roofing contractor, NABCEP Certified Solar PV Installer and instructor for Solar Energy International and the Tile Roofing Institute, stated in an interview: “Every roofer has experienced the pain, misery and frustration of homeowners who have had roof damage from incorporating equipment from the solar hot water revolution in the ’70s and ’80s. That same damage is being repeated with PV installations. Fortunately, manufacturers are designing products that meet proper roofing codes and best practices so that history does not repeat itself.”

Although manufacturers are designing new and improved products to meet roofing standards, many building departments do not mandate proper flashing methods to comply with roofing best practices. Unfortunately, this shifts the responsibility and liability onto the solar installer. The solar industry has always been focused on lowering cost and decreasing installation time, but it is essential that it also focus on quality. As a new and growing industry, solar cannot afford to risk painting a negative image of itself with poor workmanship or code violations. When installing a PV system, roof warranties, codes, installation specifications and best practices must always be considered. Returning to repair roof leaks after a job is complete takes more time and money than doing it right the first time. ●

Figure 3 This modified double-flashing detail uses a galvanized flashing installed underneath the tiles and over the underlayment instead of a peel-and-stick membrane. The flashing is sealed using the three-course method listed in the TRI manual, which consists of a layer of approved mastic or roofing cement, a layer of mesh and another layer of mastic.



Courtesy American Solar Electric

Figure 4 In retrofit installations where the standoff and primary flashing do not fall in a position that is close to the overlap of felt paper, an approach called *bibbing* can be used. When the overlapping drip edge of the felt paper ends in the tile course above the penetration, a separate piece of felt paper is positioned under the battens and overlapping felt, which then extends down to bib around the penetration.



Courtesy Quick Mount PV

which then extends down to bib around the penetration (see Figure 4). This technique allows water and moisture to drain down the underlayment and into the gutters.

Older traditional Spanish tiles and tiles that use mortar can pose significant challenges. Depending on the manufacturer's instructions, mortar and tiles may be removed and reapplied, but this approach can result in excessive tile damage because traditional Spanish or cap-and-barrel tile roofs tend to break easily. Most installers have found that the strip-and-go method of removing the tiles and installing asphalt shingle under the array provides the best solution for the more fragile tile roof systems (see "Living with Tile," Aug/Sept, 2009, *SolarPro* magazine).

AVOIDING PAST MISTAKES

In general, most tile roofs share a similar basic anatomy consisting of decking, underlayment, battens and tiles. It is essential that installers do the research to distinguish which mounting and flashing system works best on a given project. Tile roofing is one of the more complicated pitched-roof systems to deal with, but you can accomplish a watertight rack-mounted solar installation by following roofing best practices, local code requirements and roof manufacturers' instructions. As the solar industry continues to grow, more building departments will enforce roofing best practices such as double flashing on tile roofs. Learning from the past and preparing for the future allows the industry to design innovative products and improve installation methods. ⊕

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Manufacturers:

DaVinci Roofscapes / 800.328.4624 / davinciroofscapes.com
 EcoStar / 800.211.7170 / ecostar.carlisle.com
 Eagle Roofing Products / 909.822.6000 / eagleroofting.com
 GAF Materials / 877.423.7663 / gaf.com
 Hanson Roof Tile / 800.411.8453 / hansonrooftile.com
 Ludowici Roof Tile / 800.945.8453 / ludowici.com
 MonierLifetile / 800.669.8453 / monierlifetile.com
 Oatey / 800.321.9532 / oatey.com
 Quick Mount PV / 925.687.6686 / quickmountpv.com

Resources:

Florida Roofing, Sheet Metal and Air-Conditioning Contractors Association (FRSA) / floridaroofting.com
 International Code Council (ICC) site, also includes International Building Code (IBC), International Residential Code (IRC) and Uniform Building Code (UBC) / iccsafe.org
 National Roofing Contractors Association (NRCA) / nrca.net
 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) / smacna.org
 Tile Roofing Institute (TRI) / tileroofing.org
 Western States Roofing Contractors Association (WSRCA) / wsrca.com