Water Managed Roof – Re-roofing and Adding Insulation over a Flat Roof

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Scope

Retrofit an existing flat roof to improve thermal, water, and air control performance as follows:

- Remove the existing roofing membrane and inspect the roof for any deficiencies.
- Make the necessary corrections to the roof framing and decking prior to beginning the new work.
- Air seal wall cavities made accessible by roof demolition and install insulation in the roof cavity.
- Provide a continuous air control layer within the roof assembly. Ensure the roof assembly air control layer is connected to the wall (and other roof elements) air control layer.
- Install polyisocyanurate rigid foam insulation over the air control layer. Ensure that the ratio of rigid foam (“air impermeable insulation”) to cavity insulation (“air permeable insulation” meets the code requirements to avoid condensation.
- Install insulation cover board and roofing membrane with flashing as the water control layer.
- Flash around all roof penetrations, including blocking added for PV racks.
- Slope the roof deck to a drain or scuppers by installing either tapered sleepers below the structural sheathing, or tapered insulation.
- Address combustion safety and controlled mechanical ventilation as needed, given the increased airtightness associated with this retrofit.

For more on roof/wall connections, see the U.S. Department of Energy’s Standard Work Specifications.

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.
Controlling rainwater is the single most important factor in the design and construction of durable roof assemblies. The fundamental principle of water management is to shed water by layering materials in such a way that water is directed downwards and outwards out of the building or away from the building. The key to this fundamental principle is drainage.

When a flat roof is retrofitted by adding rigid foam insulation above the existing roof sheathing, the new air and water control layers must be carefully integrated with the existing roof structures.

The assembly shown here is an unvented roof assembly and must meet relevant code requirements (Table R806.4 Insulation for Condensation Control of the 2009 IRC (ICC 2009a) and Table R806.5 Insulation for Condensation Control of the 2012 IRC (2012a). The ratio of air-impermeable insulation (polyisocyanurate) to air-permeable insulation (cavity fill) must be sufficient to avoid condensation problems. Assemblies with greater depth of cavity fill insulation require more rigid board insulation. Per 2012 IRC Section806.5, the interior of the roof (gypsum board or plaster) can have a Class II or Class III vapor retarder; a Class I vapor barrier (polyethylene) is prohibited as it will eliminate drying of the assembly. For further explanation, see IRC FAQ: Conditioned Attics.

Polyisocyanurate is a suitable rigid foam for installing above the roof deck. The rigid foam can be installed over new sheathing coated with an integrated water-resistant barrier as shown in Figure 1 or the insulation can be installed over the existing roof sheathing, which is first covered with a fully adhered air control membrane that extends up the parapet sides above the flat roof as shown in Figure 2. If foil-faced polyisocyanurate rigid foam insulation is used, a protective layer of insulation cover board should be installed over it prior to installing the roofing membrane water control layer, as shown in Figures 1, 2 and 3. Glass fiber-faced polyisocyanurate can be installed without an insulation cover board.

“Flat” roofs should never be flat. All low-slope roofs must be sloped to drains (as shown in Figure 4) or scuppers at a minimum slope of ½ inch per foot (ASTM 2009). It is vital that any roof penetrations (drains, skylights, or mechanical curbs) are properly flashed to prevent water entry. The materials that form the water control layer (in this case the roof membrane) should overlap each other in shingle fashion or be sealed in a watertight manner (in the field of the roof if the slope is insufficient to rely on shingle-lapped water shedding).

Skylights, mechanical curbs, and other roof penetrations must be integrated into the roof’s drainage plane (roofing membrane) (see Figures 5 and 6). Membranes or formable flashings that line these curbed openings are all elements of the roof water control layer. These approaches work best when they are sloped toward the roof drain, so that rainwater is directed off of the building.

**Figure 1.** Existing flat roof and brick masonry walls are retrofitted with polyisocyanurate rigid foam insulation plus new OSB sheathing coated with an integrated water-resistant barrier that serves as an air control layer.
Figure 2. Existing flat roof and brick masonry walls are retrofitted with a new fully adhered air barrier membrane plus polyisocyanurate rigid foam insulation and a roofing membrane water control layer.

Figure 3. Existing flat roof and wood-framed walls are retrofitted with a new fully adhered air barrier membrane plus polyisocyanurate rigid foam insulation and a roofing membrane water control layer.
Figure 4. A roof drain is installed in an existing flat roof retrofitted with above-deck rigid foam insulation that is integrated with new air and water control layers.

Figure 5. The mechanical curb for a skylight is integrated with the water management and air control layers on a flat roof retrofitted to include new above-deck rigid foam insulation.

Figure 6. The blocking for a new PV roof-mounting system is integrated with new rigid foam and the air and water control layers installed over an existing flat roof.

How to Re-Roof a Flat Roof

1. Inspect the structural integrity of the roof. Pooling water (seen in Figure below) is a sign that more slope and drains or scuppers are needed. Remove the existing roof membrane, insulation, and sheathing (where needed) and check the roof framing for any deficiencies, rot, insect damage, etc. (see Figure below). Do not proceed if any repairs need to be performed. Based on the findings, revise the roof assembly and review specific detailing as needed. Follow the minimum requirements of the current adopted building and energy codes.
The existing flat roof before removal of membrane shows lack of slope allowing water to pool on the surface. (Image courtesy of Building Science Corporation).

Sheathing is removed from a flat roof to retrofit with air sealing, insulation, and water control layers. (Image courtesy of Building Science Corporation).

2. Remove two or three roof sheathing boards near the perimeter of the roof, leaving one or two boards at the parapet (Figure below). Mechanically fasten a strip of pressure-treated plywood to the interior vertical face of the parapet to allow for attachment of the strip of fully adhered air barrier membrane. Install a strip of OSB sheathing with an integrated water-resistive barrier at the roof perimeter adjacent to the parapet on top of the remaining board sheathing (Figure below). Provide a continuous bead of sealant between the existing board sheathing and a strip of new roof sheathing.
The existing sheathing boards are removed near the perimeter of the flat roof and pressure-treated plywood is installed at the vertical face of the parapet. (Image courtesy of Building Science Corporation).

A strip of OSB sheathing is installed along the perimeter when retrofitting a flat roof with a parapet. (Image courtesy of Building Science Corporation).

3. Spray 2 inches of closed-cell spray foam in the roof cavity at the wall perimeter to create an air barrier connection between the wall and the roof, and to provide adequate thermal resistance to prevent condensation (Figures below). The area should be free of debris and dust prior to spraying for adequate adhesion. Install fibrous insulation (e.g., cellulose) in the rafter cavities beneath the existing board roof sheathing (Figures below). Re-install the roof sheathing boards.
The insulation levels should be based on the minimum requirements for vapor control in the current adopted building code. In addition, the insulation levels should be specified in the 2009 IECC (ICC 2009b) and the 2012 IECC (ICC 2012b) based on climate zone for roof assemblies.

Remediate any hazardous conditions that will be affected (e.g., exposed or aggravated) by the planned work. Examples of hazardous conditions include asbestos, lead paint, and hazardous waste. Use industry procedures for mitigation of hazardous materials. Engage the services of a qualified professional when needed.

All of Alaska is in Zone 7 except for the following boroughs in Zone 8: Bethel, Northwest Arctic, Dillingham, Southeast Fairbanks, Fairbanks N. Star, Wade Hampton, Nome, Yukon-Koyukuk, and North Slope. Zone 1 includes Hawaii, Guam, Puerto Rico, and the Virgin Islands.

Closed-cell spray foam fills the roof joist cavities forming an air barrier between the masonry parapet wall and the roof sheathing. (Image courtesy of Building Science Corporation).

The base of the plywood parapet is air sealed with spray foam and fibrous insulation is installed in the rafter cavities in this flat roof retrofit. (Image courtesy of Building Science Corporation).