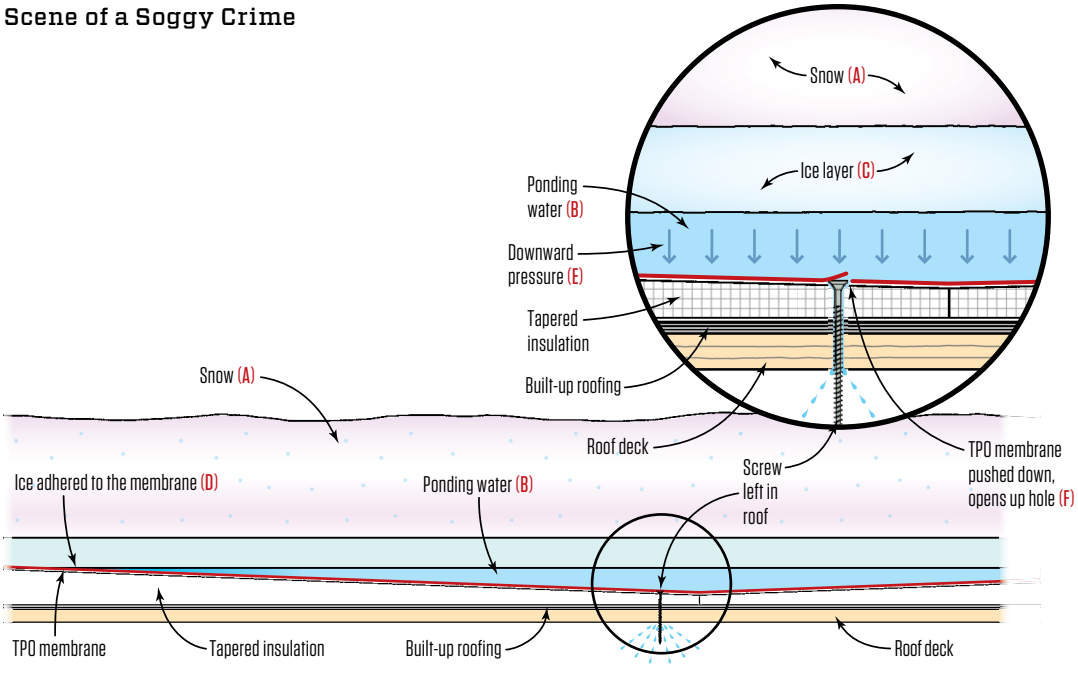
BY STEVE CLISSET

Scene of a Soggy Crime



Chain of Events Heavy spring snow falls **(A)** and begins to melt, forming a pond on top of the membrane **(B)**. Temperatures drop and ice forms **(C)**, adhering to the roof at the edges of the pond **(D)** and trapping the water below. Ice continues to form, creating downward pressure against the membrane **(E)**. Water pushes the membrane down around an overlooked screw, opening a hole and letting pressurized water flow into the ceiling **(F)**.

Mysterious Leak in Roof Membrane

I have been in the roofing business since 1973 and often get calls to help find leaks that other companies have been unable to locate. Recently I got an email from an associate about an ongoing and elusive leak in a "butterfly" roof at a home in Boulder County, Colo.

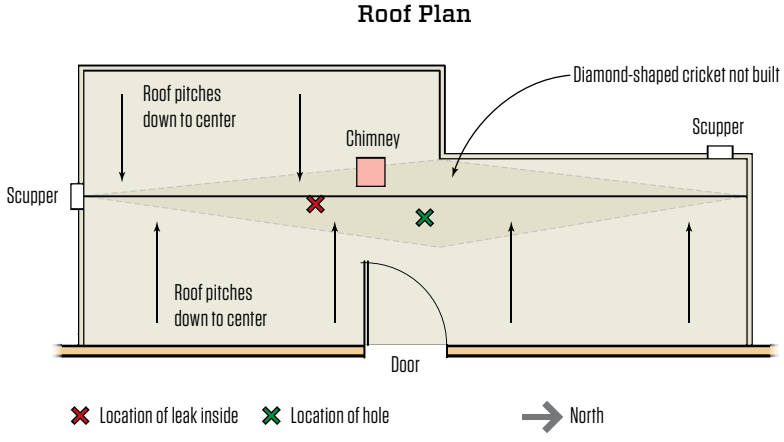
I began my investigation as I usually do: at the home talking with the homeowner. I learned that the 80 mil TPO membrane roof leaked only in the springtime and only after a snowfall of 9 to 12 inches. If the snowfall was less than that, the leak didn't show up. Spring snowfalls of that amount are common in this area, so the roof had leaked in each of the six years since it had been installed.

The TPO membrane replaced an EPDM membrane roof, but the original built-up roof system had been left in place. A taper system was added to create a 1/4-inch-per-foot pitch from the long sides of the roof down to the approximate centerline. I also learned that the crew was originally supposed to install a diamond-shaped cricket on the roof that would have pitched toward the scuppers, but the cricket wasn't built because the contractor thought it would interfere with the doorway onto the roof.

At first glance, the membrane seemed to be correctly installed, and I was surprised that it was leaking. Over the years counterflashing had been added, patches applied, and new scuppers installed. That particular day the roof was dry and the leak was not active, so I spent a lot of time "nose down and butt up" examining the membrane near the leak and at the outflows. I did find some scuffs from snow shovels, but no definitive holes or breaches of the membrane. I peened the outlets of the scuppers so they rolled downward, minimizing the possibility of water working its way back to the house via surface tension. I also caulked a couple of possible cuts, but I really wasn't sure that I'd fixed the problem.

A few days later, we had a spring snow with more than a foot of accumulation. All day long I expected a call from the homeowner, but it never came. By dinnertime I thought I was in the clear. Then, at about 9:45 p.m., I got an email saying that the leak had just started. This, it turns out, was a key bit of evidence.

First thing in the morning I headed to the house. Once inside, I saw water dripping steadily from a half



Instead of installing a cricket under the new TPO membrane, the roof was pitched to the middle and ponding occurred. The water then gushed into the roof system, via a breach in the membrane, and flowed south before leaking through the ceiling.

dozen places in the ceiling with buckets under each one. Up on the roof I discovered an ice-encrusted pond in the middle of the roof along the low point. When I stepped onto the ice, it cracked to reveal about 1¼ inches of ice over about 1½ inches of water with about 6 inches of snow on top of everything. It was obvious that the leak was somewhere under the ice-encrusted pond.

I shoveled off the south half of the roof over to the area of the leak and got rid of as much water as possible. At this juncture I noticed that the scuppers were a bit high, which contributed to the ponding effect, but I still didn't find anything obvious. I went back inside and cut through the ceiling from below, looking for clues. This was the "fun" part, as every cut I made unleashed more water that combined with drywall dust and ran down my neck.

Once things were opened up, I found a lot of moisture — most of it on the bottoms of the joists and on the ceiling drywall. However, the joists got progressively wetter north of where the leak had shown up.

I went back up, shoveled off the north side of the roof and repeated the "nose down, butt up" routine. This time I discovered the tiniest hole in the membrane about 10 feet north of the leak location inside. The hole was over a screw, probably left from when the original EPDM membrane had been removed. It was barely visible until I pushed down next to it. With pressure against the screw head, the hole opened up like a flap. It was hard to imagine a hole that small could cause so much damage—until I thought through the logic of it.

The spring snow was particularly wet and had been falling and melting somewhat during the day. The leak didn't start until after the roof had had time to freeze, hence the 9:45 p.m. time frame. So how, exactly, did these conditions cause the roof to leak only in this specific scenario?

When snow melts, the water created builds up below the snow pack. When water freezes, it freezes from the top down. So the ice was getting thicker from the top down throughout the evening, creating a pocket of water beneath it.

Water also expands as it freezes, and the initial layer of ice can expand in all directions at the same time. But once the top layer has frozen solid to the membrane along the edges, any ice forming can only expand downward, adding pressure to the bubble of water below the ice. This pressure from the thickening ice, combined with additional snow weight, pressed down on the membrane around the screw head, finally causing the tiny flap to open like a valve, and the water—under pressure—squirted into the roof system.

In fact, the hole itself might have come from this ice-expansion effect. Maybe that first year a significant snow fell and froze solid down to the membrane. In those conditions, the pressure would be extreme and the cold membrane would be at its most brittle. Conceivably, the pressure at the screw head, combined with the brittleness, could have caused this tiny fracture, which then stayed unnoticed until conditions were perfect for the leak to occur.

The fix was simple: a patch applied over the hole. Once our spring snows stopped, a cricket was installed to minimize ponding. Had the cricket had been installed initially, the leak probably never would have occurred.

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