MOISTURE, LEAKS, AND PRESSURES IN MOBILE HOMES

The first challenge is to determine whether the problem is moisture condensing in the ceiling, or a roof leak, or both. To find out, look for penetrations in surfaces.

by CAL STEINER

MICHAEL COOPER

Weatherization professionals learn from a demonstration mobile home at the 2003 National Weatherization Conference.

Moisture problems in mobile homes have been a thorn in the side of weatherization personnel in North Dakota since we started weatherizing these beasts in the 1980s. Many false assumptions have been put forth concerning the causes of and solutions to these problems. This in itself has stopped many agencies from implementing cost-effective weatherization measures on mobile homes—for fear of causing more problems.

The moisture problems I want to discuss here are not necessarily the ones that are caused by high relative humidity (RH), low air exchange rates, and/or high moisture output inside the home. The problems I will address in this article are caused by the condensation of moisture in wall cavities, in attics, in the spaces between windows and storm windows, and, to a lesser degree, in the belly space. With that said, however, high RH in the home will definitely contribute to moisture problems in cavities—and it should be addressed.

"Coffee stains" on a ceiling are an obvious sign that there is a moisture condensation or leak problem in the attic. Wall cavities with significant moisture will show signs of wood rot in the baseplate and the rim joists. In either situation, mold growth can be present, especially if the siding is sealed tight or caulked.

The first challenge is to determine whether the problem is moisture condensing in the ceiling, or a roof leak, or both. To find out, look for penetrations in surfaces. It can be as simple as this: If you see holes into the attic and wall cavities from the outside of the home, suspect leaks. If you see holes into attic and wall cavities from the inside of the home, suspect moisture problems. It is possible that you will find both.

Identifying Leaks in Various Locations

Some elements of mobile home roof construction are especially prone to leak.

Roof systems with screws that attach the metal roof to the heel plate—a 1 x 2, 2 x 2, 2 x 3, or 2 x 4 located on the top wall plate on the edge of the roof—can be a problem. Any screw that is put through the roof into a solid wood member, such as a truss, will cause a leak. Usually these screws were installed to stop the roof from chattering during high winds. Screws put into plywood plates under the metal roof surrounding a vent or flue will not leak as much as screws put through a metal roof into a solid truss.

Cracks that result from metal fatigue are leak spots. These are generally found near the edge of the roof and are caused by wind or excessive walking on a roof. If the metal roof has wrinkles in it, look for stress fractures.

Leaks along seams in a metal roof are common. Severe rusting of the roof will also cause leaks. Broken mushroom vents that cover plumbing stacks are also good candidates for leakage.

The area around a bathroom vent can exhibit the same visual characteristics as a roof leak or a moisture condensation problem, but the problem can be more obvious than that. It's not

unusual for a bathroom fan to be vented directly into an attic or to have a detached flex duct. Venting to the outside and fixing any leaks in the flex duct will solve the problem.

For wall leaks, look for visible penetrations in the siding or for leakage from the J-channel or the rain gutter area.

If you find none of these telltale signs of leaks, the coffee stains, rotting structure, or mold growth may be caused by a moisture and pressure problem.

Moisture, Pressures, and Condensation

Three things are necessary for moisture to become a problem in an attic or wall cavity. These things are pressure, a hole, and a condensing surface. All three can be present in mobile homes. Certain mobile home furnace closet designs will increase the chance of there being condensation problems.

These furnace closets are divided into two categories: open and enclosed. An open furnace closet is one in which the furnace is visible from the hallway; it does not have a door with a grille on it. When the fan comes on, it draws its return air directly from the hallway. It only slightly depressurizes the immediately surrounding area.

An enclosed furnace closet is one in which the furnace has its own room. To see the furnace, you must first open a door. With this construction, the furnace closet will become severely negatively pressurized when the furnace fan is activated. Any cavity with a bypass leading into the furnace closet will become negatively pressurized as well.

To understand how moisture is forced into the attic or wall cavities, you must understand the action that a furnace fan can have on the ductwork, the attic and wall cavity, and the interior of the mobile home. The furnace fan can act like a blower door. When the fan is activated, it can either pressurize or depressurize certain areas, depending on whether it is drawing outside air into the furnace closet (from a penetration in that closet), or forcing air out of the mobile home through holes in the ductwork.

Five scenarios demonstrate how furnace fan pressure can affect not only moisture in cavities, but also furnace efficiency and comfort.

1. Mobile homes with holes in the ductwork.

When there are holes in the ductwork, the main body of the mobile home will become depressurized. The furnace fan will have the same effect as a blower door in exhaust configuration. The duct leaks to the outdoors can add up to a significant supply leak, creating an overall negative pressure within the living space.

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Is this ceiling damage caused by a leak, or by condensation on a cool surface?

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Roof seams, and screws in trusses are typical leak sites.

A major consequence of this scenario will be backdrafting of any atmospheric appliance in the pressure zone. This can include the water heater, if a bypass from the water heater to the main body of the house exists. Furnace efficiency will be reduced as the cold air is drawn into the negatively pressurized structure. This scenario will not usually cause cavity moisture problems, since the cold air will dry the home as it is brought in. But in hot and humid cooling climates, the flow of moist outside air into the building envelope can lead to condensation.

To test for this scenario, check the pressure from the house to the outside with the furnace air handler on, making sure to account for the baseline pressure. You would like to see 0 to -1 Pa. Use the pressure pan to test each floor register and seal all leaks in the ductwork to achieve the proper pressure reading. Don't forget to do a pressure pan reading on the furnace plenum—it is the largest duct connection in the system, with the hottest air and the highest pressure. This is easily accomplished by sealing the grates and any cracks on the blower compartment panel of the furnace itself, and depressurizing the mobile home to -50 Pa. Then take a reading by inserting a probe into the blower compartment—the closer it is to 0 Pa, the better. Be sure that there aren't any makeup air slots in the furnace cabinet, since this will cause a high negative pressure. Seal any air leakage if the plenum is easily accessible from the inside. If it is accessible only from the crawlspace, -3 Pa is the action level.

2. The interior doors are not undercut enough to allow proper air return to the furnace.

This scenario is most commonly found in mobile homes where the belly cold air return system (CARS) was eliminated by insulating the belly and installing a return air grate on the furnace door. These interior doors generally extend very close to the floor and do not allow air flow back to the main body of the house, which creates a high positive pressure in rooms with the door shut. This actively forces warm, moist air into the wall, attic, and window cavities, creating condensation and moisture problems.

Use the room-to-room pressure test with the air handler on to check for this scenario. Activate the furnace blower and take a pressure reading between the room and the main body of the home with the door closed. The acceptable reading should be +3 Pa or less. If you encounter a high pressure, undercut the door or add a grate between the room and the main body of the house. This will allow air to flow back to the furnace.

3. The "enclosed" furnace closet has major penetrations in the floor or ceiling that allow the air handler to draw outside air into the furnace closet.

These penetrations are usually cutouts around the flue, makeup air vents, or holes

in the floor for piping. When the air handler is activated, it sucks cold outside air into the furnace closet. This positively pressurizes the structure; forces warm, moist air into the wall, attic, and window cavities; and creates condensation and moisture problems in those cavities. The bigger the penetrations in the closet, the higher the positive pressure and the bigger the problems.

A visual inspection of the furnace closet will reveal any penetrations that need to be sealed. Use a blower door to check for penetrations behind the furnace that cannot be seen. Another test for this scenario is to check the pressure from the house to outside with the furnace air handler on, making sure to account for the baseline pressure. You want to see this reading close to 0 Pa.

4. The "enclosed" furnace closet has a major penetration in the ceiling and the roof is relatively tight to the outside.

This scenario allows the air handler to negatively pressurize the attic area, which in turn will draw warm, moist room air into the attic via plumbing chase ways in the walls or any penetrations in the ceiling. Once this air is drawn into the attic, it will condense during the winter months and freeze. Many times when we walk on the roof of a mobile home with this scenario, we can hear and feel the ice cracking under the roof. This happens when the foam core gets saturated with moisture. When the temperature warms up a bit, this ice will melt and leak onto the ceiling.

To test for this scenario, turn on the furnace air handler and take a pressure reading by inserting a pressure probe into the attic space from the main body of the house. The door to the furnace closet should be closed. If there is a negative reading of greater than -1 Pa, there can be a leak to the attic. Don't forget that leaks in the ductwork also can cause negative pressures. You should also conduct a visual inspection for penetrations.

To alleviate this problem, seal all penetrations between the furnace closet and the attic.

5. There are penetrations in the enclosed furnace closet between the attic and the belly, and the duct system leaks.

With this scenario, air is brought into the furnace closet and is forced out the ductwork. The home will stay relatively pressure neutral, depending on the size and location of the penetrations involved. We do not generally see moisture problems in these homes.

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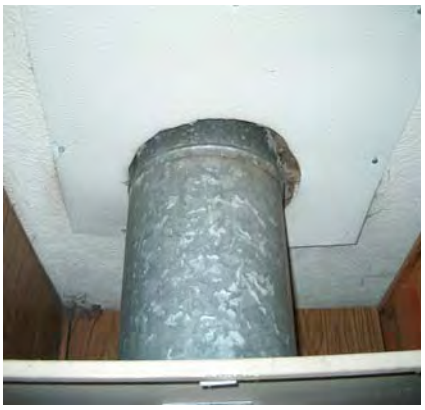
This cold air return system (CARS) is in an enclosed furnace closet..



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The penetrations around the flue into the attic should be sealed.

Finally, remember that if a home has no moisture problem before weatherization, we can cause one if we do not address all the pressure problems. If we just do a partial weatherization, we run the risk of leaving the home worse than we found it.

Bellies and Moisture

Generally speaking, we do not see moisture condensation problems in belly areas. Most of the deterioration of the rodent barrier is caused by water leaks from pipes and drains, or by the plumber cutting holes in the barrier to thaw pipes. I'll save the pipe freezing discussion for another time. However, just for the record, belly insulation done correctly will not cause pipes to freeze.

Now back to the rodent barrier. Some deterioration may be caused by leakage from the wall edge into the belly, especially if the skirting is not correctly installed.

If the crawlspace has a high level of ground moisture, the belly should be insulated, and the skirting should be vented or intentionally left somewhat leaky. In most cases, ground cover vapor barriers do more for crew comfort during the belly patching work than they do to stop moisture problems in the belly! Ground cover vapor barriers can't do any harm. However, my experience has shown that in most cases it's a waste to spend time and money on something that does absolutely no good. In my opinion, there should be a clear reason for laying a moisture barrier; it's not an everyday prescriptive measure.

Eliminate the Pressure Differences and Eliminate the Problem

The good news is that if we do our air sealing, duct sealing, and conductive heat loss insulation measures—insulate walls, attics, and bellies—we will alleviate the potential for moisture problems by eliminating pressure differences and stopping air flow into cavities. If we insulate the wall and attic cavities correctly, with blown fiberglass insulation to an approximate density of 1.6 lb/ft^3, we reduce or stop the air flow into and through these cavities. So if you implement a complete mobile home weatherization program, not only do you save energy, but you also cure or stop moisture problems in mobile homes. For years, many agencies in the Dakotas, Colorado, Montana, and other states have been accomplishing just that with a complete mobile home weatherization program.

Cal Steiner is a residential energy specialist for the North Dakota Department of Commerce, in Bismarck, North Dakota.