

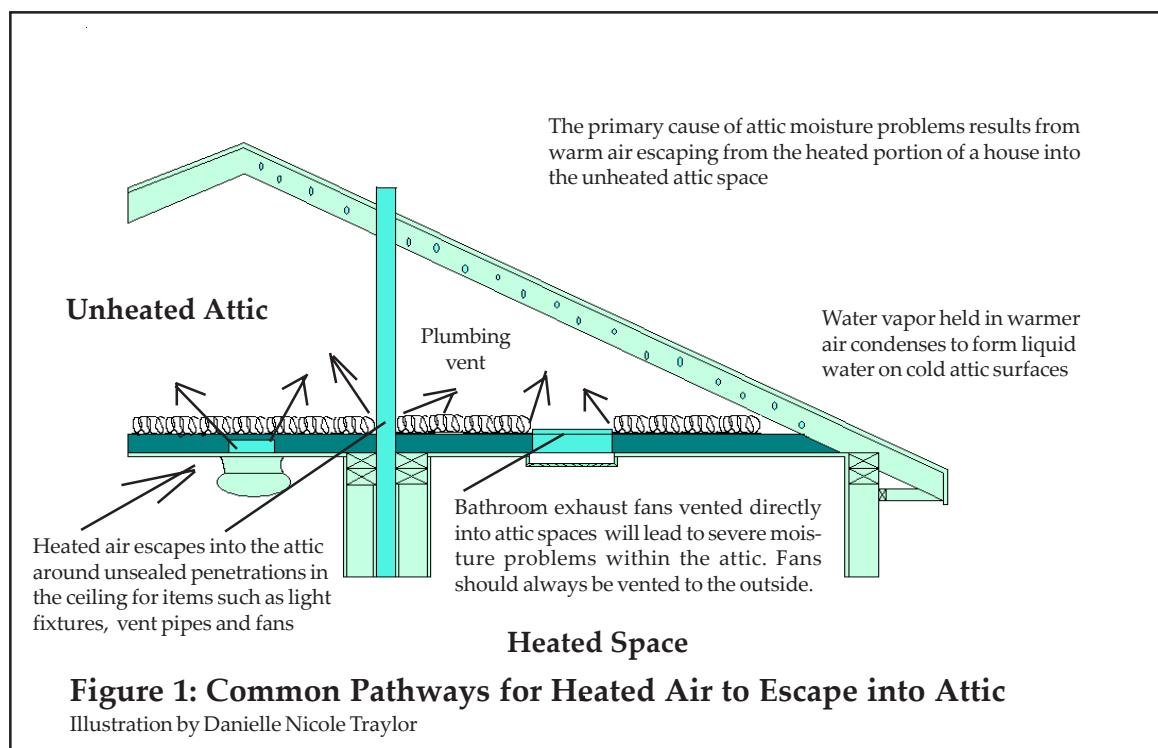


Housing Fact Sheet

Causes and Cures of Attic Condensation and Roof Ice Damming Problems

Attic condensation during winter can decrease the effectiveness of insulation and over time can cause significant damage to structural elements in the attic such as rafters or trusses. And the same factors that cause attic condensation problems also cause ice build-up on roof edges, which can lead to ice damming. If ice damming occurs it often results in snowmelt water entering the home with the potential of causing significant water damage to the home's interior.

Attics tend to be very inhospitable places (blazing hot in summer and freezing cold in winter) so the average homeowner seldom visits the attic to check its condition. Therefore, if an attic condensation problem does exist, it often goes undetected until significant damage has occurred. As mentioned previously, the same factors that cause attic condensation problems also cause ice build-up on roof edges. So if you have noticed that you have lots of icicles hanging from the edge of your roof, it is also probable that your attic has condensation problems.



Causes of Attic Condensation Problems

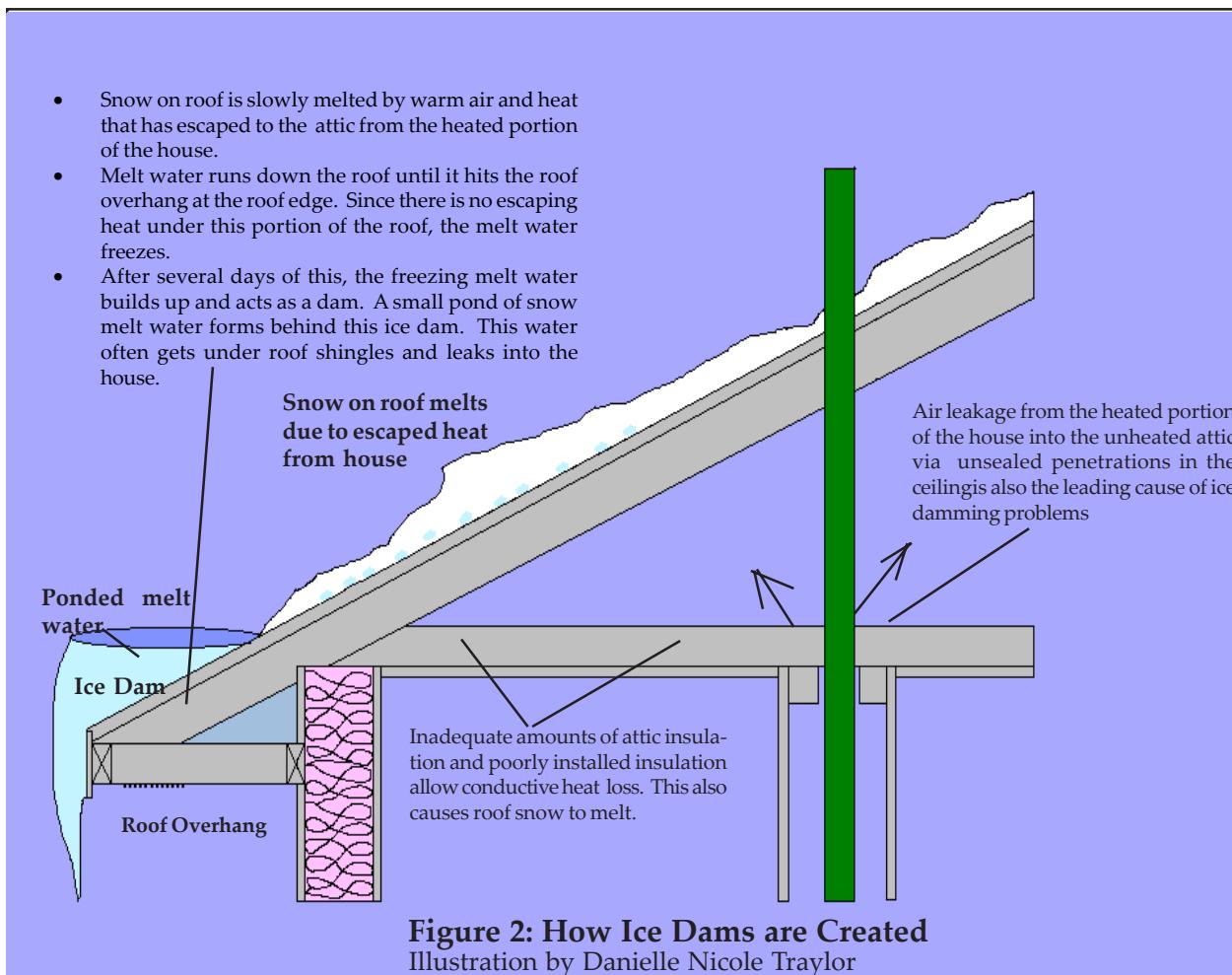
The primary cause of attic moisture problems is due to moisture transported from the heated portion of the home into the unheated attic via airflow (see Figure 1 to learn more about where heated air escapes to the attic). This occurs during the winter heating season. While moisture contained in the escaping house air is responsible for the condensation problems, the heat contained in the escaping air is the primary cause of the ice damming problem. The escaping warm air raises the temperature of the attic above 32 degrees causing any snow on the roof to melt and run down to the colder roof edge where it freezes and turns to ice. Improper installation of attic

insulation also contributes to ice damming problems (see Figure 2 for a detailed description of how ice dams occur).

The first step in managing attic moisture problems is to manage moisture within the living area of your home. Managing moisture levels can be divided into two basic areas:

1) Reducing Excess Sources of Moisture

This involves reducing moisture sources in the home and avoiding activities that can generate very high levels of moisture (see Table 1 for the amount of excessive moisture produced)



Avoid or address the factors listed below to keep moisture generation levels during the winter within manageable levels.

- Clothes dryers have built-in exhaust fans that are designed to vent the hot moist air extracted from clothing. Dryers should *always* be vented to the outdoors, even in the coldest weather.
- Never store large volumes of firewood within the heated area of the home. Even firewood that appears dry can contain significant amounts of water that can evaporate into the house as it dries.
- It is not necessary to use a humidifier to maintain comfortable levels of indoor relative humidity in a well insulated and properly weatherized house. Doing so can produce excess amounts of moisture that can have a negative impact on indoor air quality. Also, poorly maintained humidifiers can be a breeding ground for harmful bacteria.
- Unvented heaters release tremendous amounts of water vapor into a house. If you will be purchasing a kerosene or gas space heater, spend a little extra money and get one that is vented to the outdoors. Doing so will significantly reduce indoor air quality problems and the potential for moisture damage to the structural components of your home. If you already have an un-vented space heater, be aware that manufacturers do not recommend extended use of these appliances. Refer to the owner's manual to learn the maximum number of hours per day the appliance should be used. Also, open a window while the unvented appliance is in operation to allow moisture and other combustion pollutants to escape.

Table 1:
Activities that create excessive moisture

Item or Activity	Amount of Moisture
Non-vented clothes dryer	2 to 3 quarts per load More if it's a gas dryer
Green firewood stored inside	1 to 2 quarts per day per cord
Humidifier	Many average about 1 quart per hour
Non-vented kerosene heater	3.8 quarts of water per gallon kerosene burned
Non-vented gas fireplace or heater	1 gallon water per therm of gas burned
Ground moisture migration from a damp crawl space or basement	Can be 13 gallons per day or higher
Plumbing leaks or rain and snow-melt penetration can also create moisture problems within the house.	

2) Ventilation in High Moisture Areas

Significant amounts of moisture are generated during the process of living in and using our homes. Everyday activities such as bathing, cooking and doing laundry produce moisture in the form of water vapor. The amount of water vapor produced by these activities typically does not have a negative impact on the building or its occupants if this moisture is quickly vented to the outdoors by an exhaust fan. If you do not have exhaust fans in bathroom and kitchen areas consider having them installed. If that is not possible, then open a window slightly during periods of high moisture generation to allow excess water vapor to escape. If you already have exhaust fans, pay attention to the following issues to make certain the fans are doing an effective job of ventilation:

- Exhaust fans *must* be vented to the outdoors, not into attics, overhangs, crawl-spaces, etc.

- The fans must be operating correctly. That is they must be drawing air out of the room where they are located. Just because you have a fan in the bathroom and kitchen that makes a noise when you turn it on, don't assume that it is actually drawing air out of the house. Duct work can become clogged so that air flow is blocked. The fan may be undersized or it may just be a poor quality fan. Camroden Associates developed two simple tests to check how well an exhaust fan is working. The first is a visual test. Puff a cloud of baby powder toward the fan grill from about 6 inches away. If the fan is working correctly the powder should be drawn into the grill. If it is sucked into the center of the grill and blown back out at the grill edges, the exhaust duct is blocked. If the powder simply hangs in the air and is not drawn into the grill, the exhaust fan is not working. Figure 3 on page 5 provides directions on how to make a simple device to measure exhaust fan air-flow rates.
- Bathroom fans should remain on during showering, and for at least 15 minutes afterwards. Installing a hand crank timer is an easy way to accomplish this. An electrician can easily install such a device.

Determining if Your Attic has a Condensation Problem

If you have significant ice build-up on roof edges during winter, you can assume that your attic also has condensation problems. You can climb into the attic and inspect for signs of condensation. If you do so during the winter, you may actually observe condensation or

frost. Look at the underside of the roof boards for water droplets, or if it's below freezing look for signs of frost. Water and frost are often most visible on the ends of roofing nails that have penetrated plywood roof sheathing or boards. If you check the attic during the summer, look for visible signs that moisture has been present. Water stains resulting from roof leaks will be confined to relatively small areas, while water stains caused by condensation will cover a very large area. Mold growth covering a large area on the underside of the roof sheathing also indicates that attic condensation is a problem.

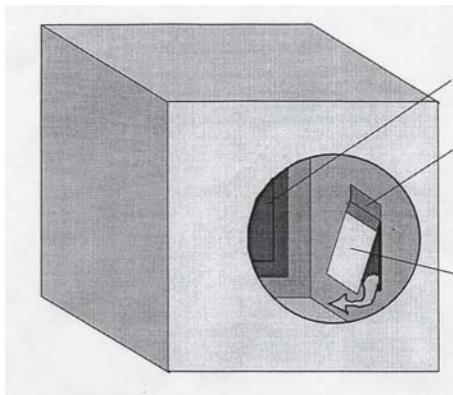
Fixing Attic Condensation & Roof Ice Problems

To fix attic moisture and ice damming problems address these 3 factors:

- 1) **Prevent warm air in living spaces from infiltrating into the attic with a good air barrier between the heated portion of the house and the attic.**
 - Properly finished drywall or plaster on ceilings provide an adequate air barrier. But significant air leakage occurs wherever there are penetrations in plaster or drywall ceilings. Most insulation products are not effective air barriers, so even well insulated attics can have significant air leakage problems. Plumbing vent pipes, chimneys, recessed lights and attic access stairs are examples of penetrations that need to be carefully air-sealed. The typical homeowner does not have the expertise, equipment or experience to adequately do this job. Therefore, it is advisable to seek the services of a professional to find and seal air leaks (see information at the end

Directions for Making and Using a Simple Device to Measure Fan Air-Flow.²

Making The Device



Use a cardboard box with an opening on one side that is large enough to fit over the fan grill.

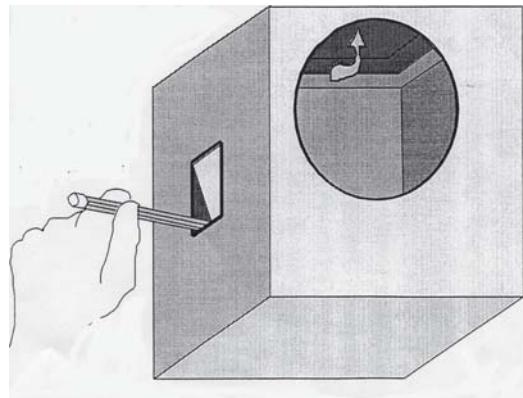
Cut a hole in a side of the box just a bit smaller than a credit card.

Attach the narrow end of a credit card to the inside of the box with a piece of duct tape. The tape should act as a hinge and allow the card to swing freely toward the inside of the box.

Using the Device

Press the open side of the device to the ceiling or wall so the exhaust grille is inside the box and turn the fan on.

If the fan is actually exhausting, air it will suck air through the credit card hole swinging the credit card into the box and out of the way. The more air the fan is pulling, the further into the box the credit card swings.



Measure from the edge of the box to the bottom of the credit card

If the credit card swings into the box 1.5 inches or more, the fan is pulling about 25 cubic feet of air per minute out of the bathroom. This will likely provide an adequate amount of ventilation for a bathroom. If the card swings into the box less than 1.5 inches, you should consider replacing the fan.

²Source: *Air Flow Rates* developed by Brennan & Clarkin. Camroden Associates, Westmoreland, NY

of this document about how to find a qualified professional in your area).

2) Prevent conductive heat loss between living areas of the home and the unheated attic by making certain that attic insulation levels are adequate and that insulation is correctly installed.

- The United States Department of Energy (DOE) recommends that ceilings (both regular and cathedral ceilings¹) have insulation levels of R-49. A 15 inch thick layer of cellulose insulation or a 27" thick layer of fiberglass insulation is required to obtain an R-49 insulation level. Few attics are insulated to these recommendations. Doing so can significantly reduce home heating bills. Combining proper levels of insulation with air-sealing will prevent both attic condensation and ice damming problems.

3) Provide ventilation of non-heated attic spaces

- Even with sufficient insulation levels and a good air seal between the attic and heated spaces below, some heat may escape. Attic ventilation is suggested because it can draw this heat from the attic before it can accumulate and begin to melt roof snow. It also keeps the roof cooler in summer. In addition, building codes often require attic ventilation. Open attics should have 1 square foot of vent area for every 300 square feet of ceiling area. Cathedral ceilings should have 1 square foot of vent area for every 150 square feet ceiling area.
- The most effective attic ventilation strategies divide ventilation area equally

between soffit (roof edge) and roof peak areas. Correctly installed soffit ventilation allows air into the attic area, but also protects insulation from the negative effects of wind washing (see Figure 3).

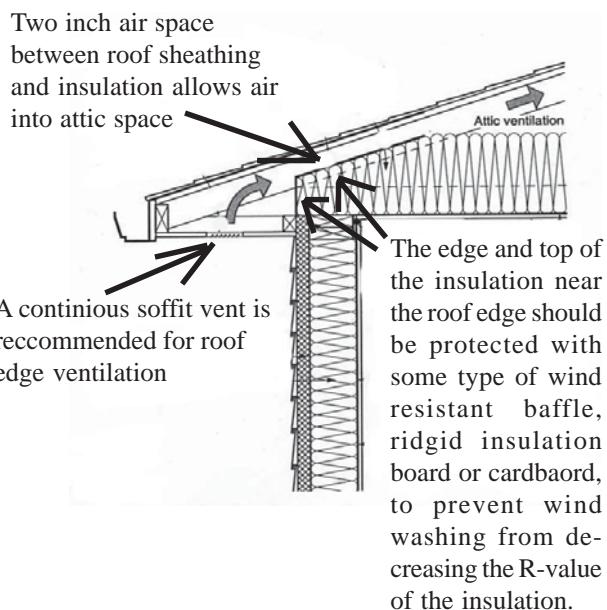


Figure 3: Attic Ventilation Details

Conclusion

This Fact Sheet has provided basic information about what factors cause attic condensation and roof icicles and what needs to be done to correct these problems. The three factors most directly linked to attic condensation and ice-damming problems are leakage of heated air into unheated attic spaces, too little attic insulation, and/or poor installation of attic insulation, and inadequate attic ventilation. Reducing excess sources of moisture in the home and making certain there is adequate spot ventilation in high moisture areas is also important. Doing so will also improve indoor air quality.

¹ However, if you have electric heat DOE recommends cathedral ceiling insulation levels of R-60.

Most homeowners are capable of monitoring and controlling indoor moisture levels. Following the basic methods described in this Fact Sheet for checking bath and kitchen exhaust fans is also within the capabilities of most homeowners. But diagnosing attic air-leakage rates and insulation levels and then taking steps to remedy identified problems is not something that many homeowners are capable of. Therefore, it is strongly recommended that homeowners work with a qualified and certified home performance professional. Contractors who have been certified by the *Building Performance Institute* (BPI) have demonstrated to a third party testing and oversight agency that they have the required knowledge and diagnostic equipment to do this type of work (see Figure 4). To locate a BPI certified contractor in your area of New York State, go to <http://www.getenergysmart.org/GES.portal> and click on the link: Find-A-Resource Map for: ENERGY STAR® Homebuilders, Products Retailers & Home Performance Contractors near you. This will bring up a map of New York State. Click on your county to see a list of BPI certified contractors that serve your area. If you do not have access to the internet you can also find a list of BPI certified contractors in your area by calling 1-800-222-0050.



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Diagnostic Tools

Certified BPI contractors use a special piece of diagnostic equipment called a blower door to find air leaks in homes. A blower door consists of an adjustable panel and a powerful fan. The panel is fitted into the exterior door opening of the house leaving an opening just large enough for the fan. The fan is placed in this opening and turned on. The air being drawn out of the house by this powerful fan is replaced by air being pulled into the house through cracks and holes in ceilings, walls and floors. A technician walks around the house using a device called a Smoke Pencil to locate where the air leaks are. Once found they are plugged using foam insulation and/or caulking.

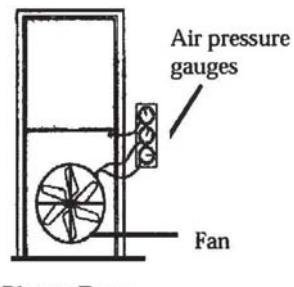


Figure 4

If you would like to learn more about the issues discussed in this Factsheet the following publications may be of interest.

Housing Fact Sheet, Insulation Check-Up
<http://www.cce.cornell.edu/housing/>

Insulate and Weatherize (2002). By Bruce Harley. The Taunton Press. Newtown, CT.

Moisture Control Handbook () By Joseph Lstiburek and John Carmody. Van Nostrand Reinhold,. New York, NY.

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February 2005