# There is Mold in My Attic !!!

One of the most common claims that we have investigated is the “sudden” appearance of moisture staining or mold growth in an attic or on the ceiling of a dwelling, as shown in the title photograph and Figures 1 and 2. Many of these dwellings were recently purchased or were about to be sold. In the first situation, the owners may not know the history of the dwelling: in the other they are hoping that the condition will not terminate the proposed sale agreement.

Figure 1    Mold growth and water droplets on ceiling.

Figure 2    Tea colored staining on ceiling near the exterior wall.

In some evaluations we have found that the moisture and mold growth have appeared suddenly.  For example, when the moisture damage is concentrated at an isolated spot it usually coincides with a leak above.  We often find that the isolate spot of moisture damage is down slope from damage to the shingles or roof flashing, as shown in Figure 3.

Figure 3    Roof leak at a valley.

These isolated spots of damage are usually comprised of a wet or dark stained center surrounded by an area that decreases in wetness, staining, and/or discoloration.  The pattern of wetness and staining are usually circular, but the shape and the location of the origin are affected by the slope of the building component that exhibits the wetness and/or the staining and the density or uniformity of the material.   During other evaluations we have found a drier exhaust vent that had been inadvertently disconnected in the attic when it was disturbed by a repair man.  We have also found moisture damage from sudden leakage in a water supply line.  However, if the pattern of moisture damage and/or wetness does not appear as an isolate spot with a concentrated origin of damage and the source of moisture or water cannot be found, then the source of moisture is probably from a widespread condition (Figure 4).

Figure 4    Widespread mold growth on underside of roof deck.

A widespread pattern of moisture damage in a dwelling indicates that the source of moisture is probably the condensation of airborne moisture. Condensation occurs when warm, damp air comes in contact with the cooler surfaces of the windows, the walls, the ceilings, the underside of the roof deck, the rafter framing, the gable end walls in the attic, etc. This mechanism is the same as the condensation of moisture on a cold glass of lemonade in the summer. Furthermore, the higher the quantity of moisture in the air, the more probable it is that moisture will condense on cool surfaces. The most common method of reducing the risk for the condensation of airborne moisture is limiting the quantity of moisture in the air.

In a common single-family dwelling, the quantity of moisture in the air depends on the amount of moisture generated within the living quarters and the ability of the building to vent the moisture. Common sources of airborne moisture are people and their normal living activities, plants, animals, unvented combustion, aquariums, groundwater from a damp crawlspace, a leaky basement, wet under floor furnace ducts, humidifiers, etc. Common mechanisms of ventilation in a single-family dwelling are the leakage around windows, doors, electrical outlets, etc.; the draft and venting of air from the living quarters by the furnace; the migration of water vapor through the ceiling into the attic and the ventilation of the attic; and the migration of water vapor through the walls.

An evaluation of a widespread moisture source requires considering the relative amount of airborne moisture generated within the dwelling by the occupants and their activities. We have found that dwellings with no previous moisture problems have sometimes become damaged by the condensation of excessive airborne moisture when the dwellings become occupied by large families or families with a great number of pets or aquariums. We have found dwellings damaged by condensation due to excessive airborne moisture generated by broken or improperly set central humidifiers, or by the excessive usage of portable humidifiers. We have seen where the usage of kerosene heaters has generated excessive moisture. We have also noticed that wet or damp crawlspaces and basements also generate excessive airborne moisture.

An evaluation of a widespread moisture source requires considering how airborne moisture is vented from the dwelling. Many times, the ventilation of airborne moisture has been eliminated or lessened during normal home improvements. That is, the installation of new windows reduces the ventilation of excessive airborne moisture around and through the windows. The installation of new vinyl or aluminum siding reduces the migration of airborne moisture through the walls. The replacement of a furnace with a newer more efficient one reduces the amount of air drafted from the dwelling for combustion, and thus, reduces the air exchange with the exterior. A second layer of shingles adds another barrier to the migration of airborne moisture through the roof deck and shingles. The replacement of plywood with OSB in the walls or roofs reduces the migration of airborne moisture through the walls and roof deck because OSB becomes less permeable than plywood as it absorbs moisture.

So then, how does one reduce the amount of airborne moisture? The amount of airborne moisture may be lessened by reducing the generation of airborne moisture or increasing the ventilation of airborne moisture. The generation of airborne moisture may be reduced by changing living activities or reducing the number of occupants. The former method of reduction is practical only when the occupants' activities are very unusual. And although the latter may sound intriguing to the parents of teenagers, the reduction of the number of occupants is usually unacceptable.

The preferred solution to control airborne moisture in a residential structure is to adequately ventilate the attic. That is, since airborne moisture tends to rise (like a mist rising from a lake), it rises to the ceiling, passes through the ceiling and accumulates in the attic. The migration of airborne moisture into an attic may be reduced with a vapor barrier consisting of a special moisture barrier paint on the ceiling, multiple layers of paint on the ceiling, or a plastic or foil vapor barrier on the top side of the ceiling. However, due to ceiling penetrations, incomplete coverage and/or lapping of the vapor barrier, etc. airborne moisture will eventually accumulate in the attic and it will require removal.

When an attic is adequately ventilated, the moisture laden air is vented outdoors. An attic may be vented by the free flow of air from side to side, that is, gable vent to gable vent, or from bottom to top, that is from eave vents to ridge or roof vents. If there is not a free flow of air, the airborne moisture not only accumulates, in the relatively still air of the attic, it condenses on the cold surfaces, similar to frost on a vehicle during a cold, still night.

But how much ventilation is enough? Industry standards recommend that the free vent area for attic ventilation be more than 1/150th of the attic area. Free vent area is the open area of the vent minus the restriction from insect or bird screening. If one-half of the ventilation is placed in the upper three feet of the attic and one-half is placed in the lower portion of the attic, industry standards state that the total amount of free vent area may be reduced to 1/300th of the attic area.

For example, if the subject attic has an area of approximately 1200 square feet, the attic requires 1200 ÷ 150 = 8 square feet of vent area ( 1152 square inches). But if there are vents at the top and bottom of the attic, the subject attic requires 1200 ÷ 300 = 4 square feet of vent area (480 square inches, that is, 240 square inches in the upper three feet and 240 square inches in the lower portion). The first example would require approximately two 30 inch by 30 inch gable end vents. The second example would require approximately six roof vents (most square roof vents provide 40-45 square inches of free vent area). The free vent area in the soffit at the eave usually requires continuously perforated panels (panels perforated with round holes or lanced slots). One must also remember that these are minimum requirements. For dwellings with higher than normal generation of airborne moisture, the amount of required ventilation will be greater.

When evaluating the ventilation of an attic one must also consider the distribution of the ventilation: the distribution should be relatively uniform. The vents must also be examined for blockage or restrictions of air flow. That is, the vents should not be covered with plastic during the winter months. The vents should not be blocked with poorly cut wall sheathing or roof deck (Figure 5). The presence of structural members within the free vent area, such as wall studs and roof rafters, must also be deducted from the free vent area.

Figure 5 Air flow through ridge vent restricted by narrow slot and ridge board.

The most common restriction of airflow in an attic is the restriction of air flow from the vents at the eaves by insulation being set tight to the underside of the roof deck, as seen in Figure 6. Insulation may be held clear of the roof deck with preformed baffles. Baffles are cardboard or foam troughs that fit between the underside of the roof deck and the top of the insulation. The baffles hold the insulation away from the roof deck and provide a 1 to 2 inch slot for the free flow of air from the soffit vents into the attic. Improper installation of the baffles or the insulation can cause the baffles to be crushed and render ineffective.

Figure 6 ventilation from eave restricted by insulation tight to roof deck.

Furthermore, even though an attic may be properly and adequately vented, condensation and mold growth are often seen above the discharge of a bathroom vent. Industry standards and most current building codes require that bathroom vents discharge directly to the exterior.

How can the history of a condensation problem be determined? Absent a reliable report by a reliable eyewitness, the history of the condensation of airborne moisture can often be seen in the physical evidence. The multiple rings in a moisture stain indicate that the wetting event has occurred multiple times (Figure 7). The discoloration and/or delamination of the wood indicates that the wetting event has occurred over an extended period of time. The chronological history can be better estimated considering the source of the moisture and the probable interval of recurring wetness. The degrees of decay may also show that the exposure to excessive amounts of moisture has occurred over years. Other physical evidence that may assist in estimating the time and history of the moisture damage include the following: the degree of corrosion on the nails (Figure 8); the degree on corrosion of the truss plates; previous patching and paint coverage over areas of moisture staining (Figure 9); the condition of the plastic covering, pots, or pails on the floor of the attic; the degree of discoloration under the green or white mold growth on the underside of the roof deck; the degree of mold growth around galvanized roofing nails (Figure 10); the presence of shiny or relatively clean nail shanks compared to the corroded nails (Figure 8); the discoloration and mold growth on the cut out scraps for newer roof vents; the relatively clear condition on the underside of the roof deck at roof vents (Figure 11); the relatively clear condition on the edges of the roof deck at the openings for the roof vents; and the newer, less damaged sections of roof deck, roof rafters, or roof trusses.

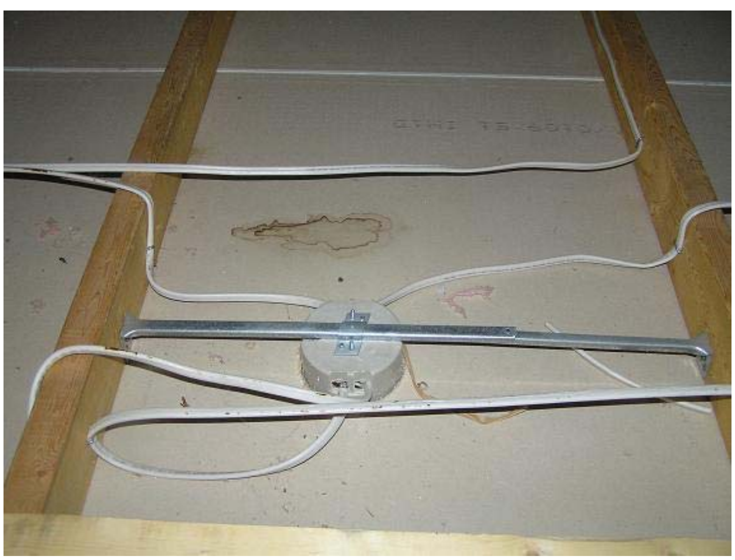

Figure 7 Moisture stain on top side of ceiling. Note multiple rings.

Figure 8    Corroded nails and clean nails present in the attic space.

Figure 9    Previous paint coverage at area of moisture staining.

Figure 10 Roof deck clear at hole for removed galvanized roofing nail. Roof deck is mold covered around newer roofing nails.

Figure 11 Roof deck clear of mold growth at roof vent.

**Conclusion**

A widespread or large area of mold growth and/or moisture staining is most often characteristic of the condensation of airborne moisture. The condensation of airborne moisture is commonly due to inadequate ventilation of the dwelling, especially of the attic or the rafter spaces. The ventilation of airborne moisture from a dwelling is a relatively simple system requiring intake and exhaust. Gable end vents, a combination of eave and ridge vents, or a combination of eave and roof vents work well unless the air intake or the exhaust is inadequate or restricted. Many factors such as, the number of occupants; the activities of the occupants; home improvements; the heating system in the dwelling; the infiltration of groundwater into the basement or crawlspace, etc. influence the amount of airborne moisture in a dwelling and attic and affect the amount of ventilation that is required. And finally, the history of the condensation of airborne moisture can often be determined by comparing the physical evidence in the dwelling with industry experience with water damage and/or by applying engineering principals.

The End