CLEMSON EXTENSION

HL 253 Rev. April 1997

RESIDENTIAL HOUSING

Controlling Internal Moisture Problems in the Home

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INTRODUCTION

Normal household activities such as cooking, laundering, bathing, breathing and temperature influence the levels of moisture vapor in the household air. The temperature of the air determines its moisture carrying capacity since warm air can absorb more moisture than cooler air. If moisture laden air comes in contact with a cold surface, the air is cooled and its moisture carrying capacity is reduced. Therefore, some of the moisture may be condensed out of the air and forms condensation on the cold surface. This is illustrated by the condensation on an iced tea glass in summer and condensation on windows in very cold weather.

Basic construction techniques and procedures can prevent or minimize most household moisture problems. Insulation, weatherstripping, storm doors and windows used in combination with ventilation can help homeowners maintain a comfortable level of temperature and relative humidity within the house without annoying problems associated with excess moisture levels. Occupants of households are usually comfortable when the temperature and relative humidity are maintained within a range of 68 to 72 ^{0}F and 25 - 50% relative humidity. Generally speaking, mildew can become a problem at a maintained relative humidity level above 60% and static electricity can be noticeable in cold weather at 20% or lower levels.

Moisture vapor tends to migrate from one area of the house to another. The moisture vapor can, unless prevented by vapor barriers or retarders, move through floors, walls, and ceilings. Figure 1 illustrates the normal tendency for moisture vapor to migrate from a warm area to a cooler area.

A temperature differential on each side of a wall immediately produces a differential in vapor pressures which causes the direction of vapor migration. Vapor pressure can be determined for a given temperature and relative humidity.

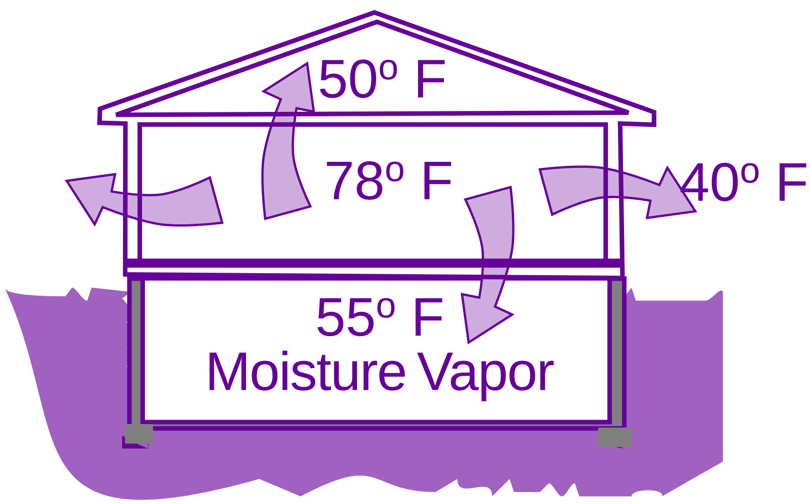

Figure 1. Temperature differentials cause moisture vapor to migrate between areas unless impeded by vapor retarders.

CRAWL SPACE MOISTURE MANAGEMENT

Enclosed crawl spaces under the suspended floor of a house vary in air volume. Some property standards suggest a minimum foundation wall height of twenty-four inches.

The ground enclosed by the foundation wall can become damp or wet. As a result, the moisture content of the floor joist is often raised to a level that will support the growth of a fungi organism on the wood joist. Some of these organisms do not damage the wood, while others are capable of total destruction.

For residential use, pressure treated floor joist and subflooring treated with a water borne soluble salt wood preservative is toxic to fungi organisms. However, if the organism growth appears on untreated joists, it is not feasible to apply a surface wood preservative or fungicide to the affected timbers. It is more practical to <u>eliminate the excessive moisture source</u>, thereby arresting the organism growth at that level of development.

CAUSES OF EXCESS CRAWL SPACE MOISTURE

The primary causes of excess moisture in the crawl space are:

(1) Surface runoff water is not excluded.
(2) Adequate ventilation not achieved by vents.
(3) Excess moisture vapor released by ground.

EVIDENCE OF A MOISTURE PROBLEM

(1) The crawl space soil is wet.
(2) Surface organism growth appears on the sap wood of some floor joist. This is usually a small “toad stool” organism, is brown or green in color and leaves a stain on the wood surface when smeared with your finger.
(3) During summer, the bottom side of the floor insulation has beads of moisture on the surface or is saturated with condensed moisture. This can develop in an air conditioned house usually in late summer. Remedial steps include adequate foundation ventilation to disperse the moisture vapor and installation of a ground cover to reduce the source of ground moisture.

ABOUT FOUNDATION VENTS

A standard metal foundation vent is 8"x16" and is usually located in the top 8 inches of the foundation, and usually under a window. It has a metal grid of about one inch squares, may have screen wire to exclude mice and pests, and may have an operating metal shutter. One standard suggestion for vent sizing is one square foot of unobstructed ventilating area is needed for each 150 square feet of crawl space area. Thus, each standard 8x16 vent has about 60 to 75 square inches of unobstructed area and is adequate to ventilate about 75 square feet of crawl space area. Ventilator location should permit cross ventilation.

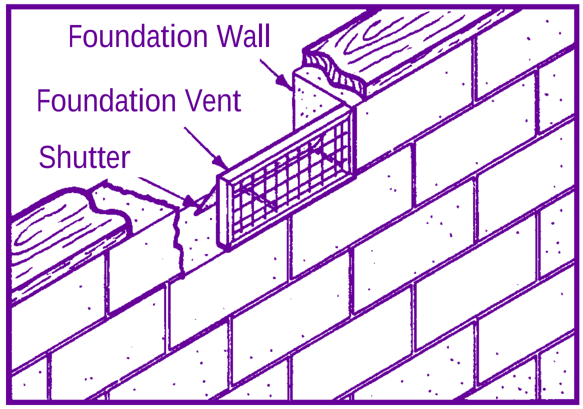

Figure 2. Foundation vents are needed to disperse crawl space moisture. One standard vent is needed for each 75 square feet of crawl space.

The function of the foundation ventilator is to dissipate the moisture vapor in the crawl space; therefore, the ventilator should remain open year round except during the coldest few days. Insulate pipes in unconditioned areas to protect against extreme cold weather and freezing.

CAUTION: Some vents are stamped in centimeters. 1 inch = 2.54 cm. If free area is stated in sq. cm., the number of required vents will be 6.25 times more than if calculated in sq. in.

ABOUT PLASTIC GROUND COVER

A literature review indicates that under laboratory conditions, with a three foot water table, twelve gallons of water in vapor form can be released per one thousand square feet each twenty- four hours.

6-mil thick polyethylene plastic ground covers are used over about 2/3-3/4 of the crawl space area to reduce the amount of moisture vapor in the crawl space air. Some ground area needs to be exposed, particularly if the house has hardwood floors. Some moisture is needed to prevent excessive drying of oak flooring and trim around doors and windows, or wood furniture joints. If the floor begins to open, or the head joint in trim begins to open, more ground can be exposed by rolling back some plastic.

In construction where all floors are covered with carpet and vinyl products, all the crawl space can be covered with plastic. Some people suggest covering the plastic with a few inches of sand to protect the plastic from light deterioration, and reduce the condensation under the plastic. Plastic on the surface will have condensation droplets frequently during cool weather. The soil under the plastic may be saturated with condensed moisture.

Plastic ground cover reduces the foundation ventilator need to one square foot of unobstructed ventilator area to each 1500 square feet of plastic covered crawl space area, or one standard ventilator for each 750 square feet.

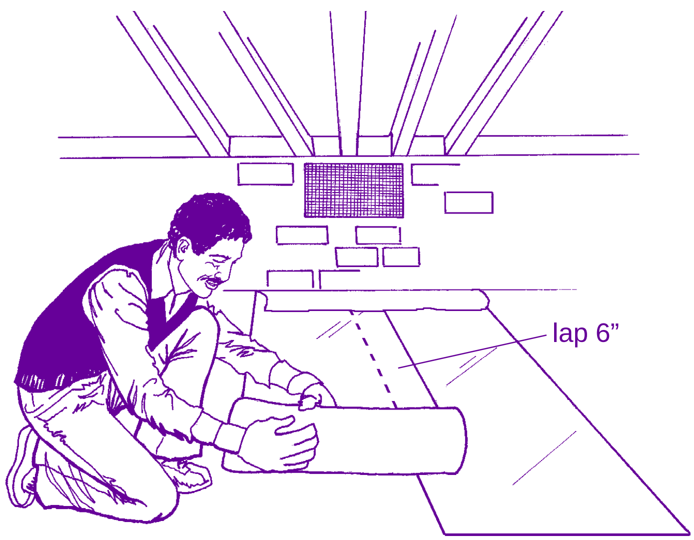

Figure 3. Ground covers will reduce the amount of moisture evaporating into the crawl space

VAPOR RETARDERS AND VAPOR PRESSURE FOR OUTSIDE WALLS, FLOORS AND CEILINGS

"Vapor retarder" is a term describing a material that resists the passage of moisture vapor through it. Retarders are needed on insulation to prevent moisture vapor from penetrating the insulation, with some of the vapor condensing out within the insulation. Such a development would cause the insulation to become wet and therefore, cease to be an insulator.

Vapor pressure is a measurable pressure at a given temperature and relative humidity. Thus, a difference in temperature on each side of a wall, floor or ceiling automatically sets up a difference in vapor pressure. This difference in pressure causes warm moisture laden air to migrate toward the cooler side of the dividing wall, floor or ceiling.

Figure IV illustrates a vapor retarder in a heated house in cold weather in both insulated and uninsulated situations. The illustration applies equally to ceiling and floors.

Aluminum foil and bituminous treated kraft paper are extensively used as vapor retarders on one side of blanket type insulation. Aluminum foil is totally resistant to vapor passage while treated kraft paper is highly resistant but not totally resistant. Polyethylene plastic is a highly resistant vapor retarder material that is sometimes installed on the living side of insulated walls, floors and ceilings.

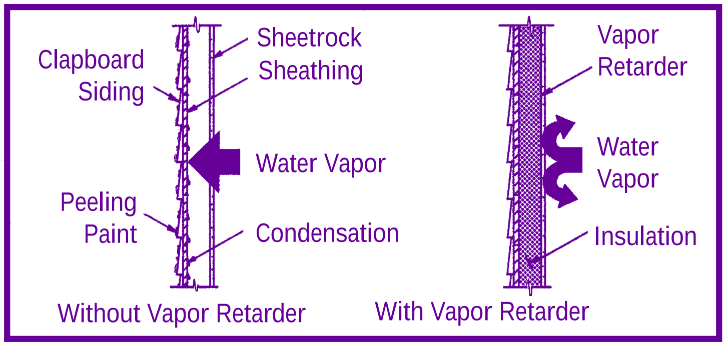

Figure 4. Vapor retarders prevent water vapor from condensing in the insulation or wall cavity. Wet insulation loses most of its insulating properties.

NEED FOR HOUSEHOLD VENTILATION

Moisture vapor within the house should be dissipated through ventilation. Ventilation would reduce the inside vapor pressure during winter by replacing moist warm air with drier cooler air. In addition, a maintained lower indoor relative humidity would tend to suppress the growth of mildew.

The daily amount of generated household moisture for a family of four is indicated below:

Bathing	1 pint
Drying clothes	26 pints
Washing	5 pints
Perspiring and breathing	12 pints
Dishwashing	1 pint
Steam from cooking	5 pints
Possible total for family of four	50 pints or 6 1/4 gallons

WINDOW CONDENSATION

Condensation on windows in cold weather can be reduced or eliminated by installing storm windows over existing window units. The air space separating the storm window unit from the regular window becomes an insulator. This space allows the temperature of the storm window unit to approach the temperature of the cold outside air while the temperature of the inside or regular window can approach the temperature within the house or at least stay above a temperature that would cause condensation to take place on the inner unit.

In new construction, or window unit replacement, double or insulating glass within the sash, coupled with weatherstripping, is another effective method of reducing or eliminating condensation.

The unusual (1) Occasionally, after a storm unit has been installed, the regular or existing window continues to have condensation. This means the storm unit does not have a tight fit and is permitting an excessive amount of cold air to reach the regular unit. Caulking around the storm unit usually corrects this problem. (2) After a storm uit has been installed, if the storm unit begins to have condensation, it is an indication that the regular window does not have a tight fit and should be weatherstripped around the sash to reduce air leakage.

ATTIC MOISTURE MANAGEMENT

Attic ventilation is a basic method of moisture management. The usual source of attic moisture is migration of moisture vapor from the living area below. Many houses have loose fill insulation blown into the attic with no vapor retarder. Some houses that do not have adequate attic ventilation have moisture condensation on the roof sheathing, rafters and gable walls. Some houses may have frost on the bottom surface of the plywood sheathing during the coldest weather. In some cases, the bottom of the roof sheathing will turn dark due to organism growth such as mildew.

For proper ventilation, attics require one square foot of **unobstructed** ventilation area for each 150 square feet of attic area. The most efficient ventilation technique would be for 50% of the ventilation to be in the soffit board and 50% ventilation capacity in a ridge vent. The natural convection currents of permitting heated air to rise will draw cooler air into the attic through the soffit vents and exhaust the air out through the ridge vent. Soffit vents are needed to make the others perform efficiently.

The two illustrations (right) show the locations and types of commercially available ventilators for attics. Figure 5 shows the location of one type of soffit vent and Figure 6 shows the locations of gable vents, and ridge vents high on the roof. Soffit vents are needed to make the others perform efficiently.

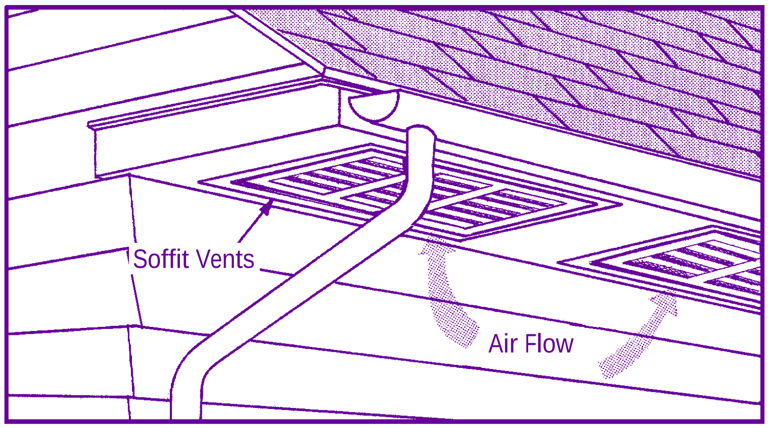

Figure 5. Soffit vents are needed to provide an air inlet and complete flow path when used with gable or roof vents.

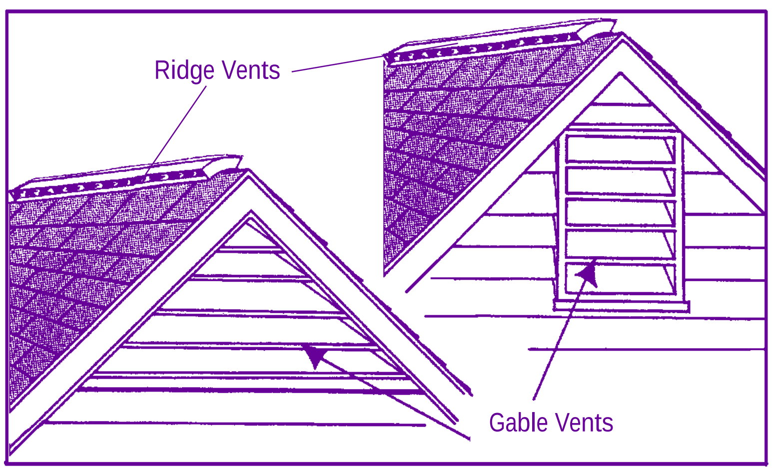

Figure 6. Gable and roof vents are needed to ventilate attics. They are used with soffit vents to provide a flow path.

ADDITIONAL CONSIDERATIONS FOR MOISTURE MANAGEMENT IN HOUSES

(1) Mildew can be an aggravating problem in houses that have "cold spots" or cold walls that cause condensation. In turn, mildew develops on these damp areas. "Cold spots" may cause mildew development along the edge of the ceiling on an outside wall. Usually, rearrangement of the ceiling insulation over these areas corrects a deficiency in coverage of the attic area. Occasionally, an uninsulated air conditioning duct located in a stud wall will induce mildew to grow on the wall over the duct.

(2) Exhaust fans in the bath, laundry, and kitchen should be vented with the discharge released outside. The amount of moisture vapor generated by a family of four varies from about 21 to 51 pints of moisture daily.

Fans should be selected for the particular job needed. The fan capacity is measured in the number of cubic feet of air it will move per minute- CFM's.

The fan size, in CFM's needed to do a particular job, may be determined as follows:

$$\text{CFM} = \frac{\text{(Crawl space) (Room) (Attic)} \times \text{number of air changes desired per hour}}{60}$$

Crawl spaces and basements need a minimum of 10 air changes per hour. Kitchens require a minimum of 10-15 air changes per hour. Bathrooms require a minimum of 8 air changes per hour.

A hood over a range on a wall should be rated at 40 CFM per lineal foot of range top, while one placed on an island would require 50 CFM per lineal foot.

Attic fans may also be installed to force ventilation. In fact, this is their most common use. Sizing is by the CFM formula, with 6 to 8 changes per hour for ventilation. Larger fans aid the cooling of mechanical equipment. Cooling without air conditioning equipment, by installation of a larger fan that will change air 30 to 60 times an hour, will usually do a comfortable job of cooling.

A **whole house** fan may be used to ventilate an entire building quickly. Generally, a whole house fan will pull outside air through the building, expelling it out the attic. A whole house fan can be used during mild weather, such as morning and evening hours of summer and during the spring and fall seasons. The fan should be sized to move at least 1 1/2 cubic feet of air per minute (CFM) for each square foot of conditioned area. Thus, a 1200-square-foot building should have at least an 1800 CFM fan. Whole house fans should not be operated during periods of high outside humidity. If they are, the moisture in the air is absorbed by wood, paper and cloth, thus creating mildew opportunities. A good rule of thumb is to operate them only if the dew point temperature is below 60 degrees F. (Dew point is the temperature at which moisture vapor in air condenses to form water.) [1]

SUMMARY

With emphasis on achieving high levels of energy efficient houses, through high levels of insulation materials with vapor retarders, excess moisture within the home can result in condensation problems, mildew growth, and eventual deterioration of construction materials and furnishings.

The most economical way to combat these conditions is to (1) **reduce** the moisture at its **source** and (2)disperse the excess moisture with ventilation. Positive ventilation and exclusion of excessive ground moisture is needed in the crawl space to keep the moisture content of the joist and sills in the 11-19% range.

Positive ventilation is needed in the living area to maintain a relative humidity in the 50% range for comfort and suppression of mildew growth even at the expense of a slightly higher energy cost.

Positive ventilation is needed in the attic to disperse any accumulation of excessive moisture migration from the living area below.

Ventilation of the insulated stud walls by drilling 5/8" holes between each stud, in both top and bottom plate, may prevent a deteriorating level of moisture condensation within the insulation. Use of serrated plastic strip along the top and bottom plates under dense manufactured sheathing boards may be desirable.

Household moisture problems are often a product of smaller, tighter houses.

[1] Cook, Gary D. Creating Healthy, Energy Efficient, and Green Building Environments: A Course for Building Professionals. University of Florida: Florida Energy Extension Service, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences. Circa 1994, p. 16.

This material was originally assembled by Frank H. Hedden and Richard A. Spray to assist with the general educational programs in the area of housing conducted by the Cooperative Extension Service of Clemson University. Revised by Linda L. Redmann, Ph.D. Extension Housing Specialist.

Appreciation is extended to Wayne Shirley, Special Investigator, SC Residential Builders Commission, SC Department of Labor, Licensing and Regulation for reviewing publication for compliance with current 1995 CABO codes.