Cold Climate Housing NEWS

Cold Climate Housing Center, Minnesota Extension Service
Minnesota Building Research Center, University of Minnesota

MnBRC Volume 3, Issue 1
Winter 1990

WORKSHOPS SCHEDULED

During February and March of 1990, the CCHC staff will be conducting educational programs for building professionals. This year's workshops will emphasize two key areas of cold climate housing: ventilation and foundations. The dates and locations of these workshops are:

Mankato	**February 13**
Rochester	**February 15**
Granite Falls	**February 21**
Worthington	**February 22**
Detroit Lakes	**February 26**
Bemidji	**February 27**
Eveleth	**March 1**
Brainerd	**March 5**
Alexandria	**March 6**
St. Paul	**March 12**
Duluth	**March 15**

For more information, contact: Cold Climate Housing Center, 203 Kaufert Laboratory, 2004 Folwell Avenue, St. Paul, MN 55108; (612) 624-9219.

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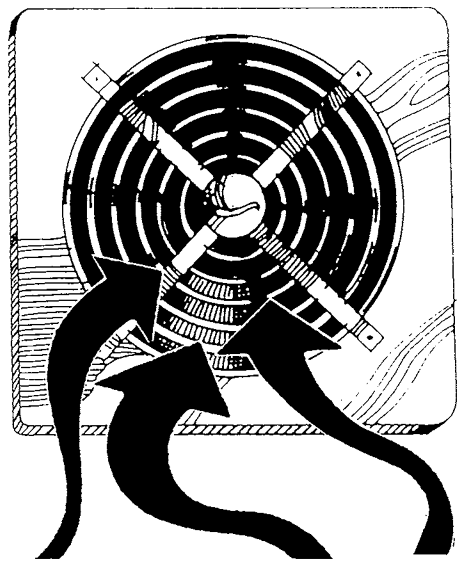
Why The Bathroom Stinks

by Stan Wrzeski, Housing Technology Consultant



The cold climate home is a complex and interrelated set of systems. Each system must be properly designed, installed, operated and maintained in order to perform properly. Sometimes the best way to learn about how a system should work is to consider the reasons why it may not work. Consider the possible reasons why something as simple as a bath fan may not be working properly...

The builder bid out the electrical work for our new home. The job was awarded to the low-bid electrician. He specified

[ ] a "fan that would save us money." It had an axial (propeller blade) fan instead of a better-quality centrifugal (squirrel-cage) blower. As a result, it draws very little air--especially in our tight home. Directly over the shower stall, where the fan was supposed to go, there was only 2 feet of clearance between the ceiling joists and the rafters. Instead of crawling in there, the electrician put the

[ ] bath fan in the ceiling next to the bathroom door. The resulting short-circuit air flow didn't circulate air to the outside wall of the bathroom. Whenever someone takes a shower, there's always

[ ] condensation on the "window that would save us money." (A higher R-value window in the bathroom would have helped.) Now the wood sash rail is stained black. A smelly green mold is starting to grow there.

When the rocker hung drywall on the bathroom ceiling he used the fan housing as a template for his drywall saw. He cut a very clean, even

[ ] slot through the vapor barrier between the fan housing and the drywall. Whenever the fan goes on, it draws some of its make-up air from the attic instead of the bathroom because the home is very tight.

[ ] The flex duct was crimped when the insulation contractor tripped while blowing insulation in the attic. He got upset, lost his concentration and missed a few spots. One of those spots is an

[ ] uninsulated stretch of flex duct running across the ceiling joists. As warm moist indoor air is exhausted through the duct, it condenses. As the condensate collects, it stretches the flex duct and creates a trough of water.

Continued on page 4.

Energy-efficient Housing Requires Early Planning

by Patrick Huelman, Forest Products

The planning stage is a critical step in building any new home. The more time that builders and homeowners spend discussing the available options, the more likely they will get the most for their money. In terms of energy efficiency, there are several points that can be easily overlooked. For example, some energy-saving measures can reduce building costs and provide long-term operational savings in addition to improving the thermal and psychological comfort of a new home. Homeowners may also not know that energy-efficient housing involves more than reduced air leakage, efficient windows and high R-value insulation.

Site selection, building shape, window orientation and room placement are major contributors to a home's energy or inefficiency. Planning for these elements early on will be time well spent for everyone.

Site Selection

Choosing a site to build on is one of the most critical planning decisions. A good site should offer the potential for good energy planning. For example, a lot with a north front will allow the garage to serve as a buffer on the north or west, as well as allow more windows to be placed on the south side. It will also increase the flexibility of putting major living areas on the south and east. An energy-efficient design can be developed for most any lot, although more creative solutions and additional planning may be required.

Building Shape

Homeowners need to know that the shape of their home will not only affect its visual appeal but also how much it costs to build and operate. The more complex the building envelope--the more wall area and number of corners--the more expensive it will be to build. Figure 1 shows how different floor plan shapes with the same square footage can have varying amounts of wall area. The heat loss per square foot of heated floor area is reduced when a simple shape is used. This means better installation of the insulation and air barrier. With fewer cold spots and drafts, thermal comfort is improved and moisture problems are reduced.

Not only are simpler shapes such as a basic square or rectangle easier to build but they are easier to insulate and seal. Floor plans based on complex shapes require more insulation (higher R-values) and better craftsmanship to achieve the same performance as those based on simpler shapes.

Simple shapes may not be as interesting to the homeowner. However, they should be aware that it is usually less expensive to add unheated areas (such as a garage, entries, porches or wing walls) than it is to add complex details to the house shape. Complexities added to the core building shape will generally affect more than one floor and will likely increase plumbing, ductwork, wiring, insulating and finishing costs.

Window Orientation

Most homeowners are probably aware that there have been major improvements in the efficiency of windows. What they may not know is that window orientation can have an even more profound effect on their home's efficiency and comfort.

Especially in the winter months, south windows are important because they receive direct solar energy all day. East or west windows receive only a portion and a north window receives only indirect light.

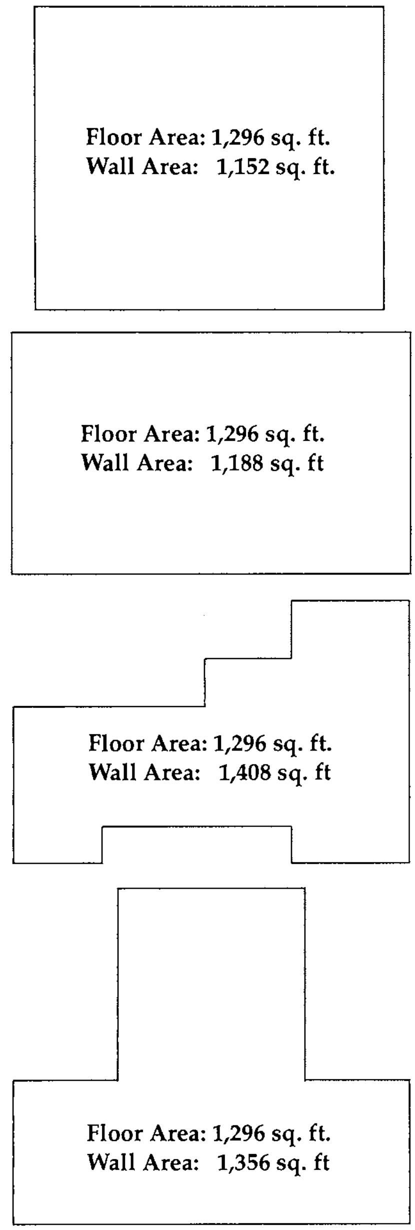


Figure 1. Comparison of wall areas for varying floor plans of equal size.

Winter winds also primarily impact north and west windows. An east window is protected from wind, but receives little solar heat. Windows facing west and north are least desirable.

Continued on next page .

In the summer months, east and west windows receive the most solar heat. If a south window has a proper overhang, it will have about the same solar heat gain as an unshaded north window. West windows are especially difficult because the solar heat comes later in the day when outdoor and house temperatures are highest. Summer breezes from the south can circulate through the house if there are windows or doors on adjacent or opposite sides.

Homeowners should be aware that south windows are best for year-round energy and comfort, while west windows are least desirable. East and north windows have both positive and negative attributes. A new plan for a home should put windows on the south first, then add north and east windows where necessary for light, ventilation and view. West windows should be avoided whenever possible.

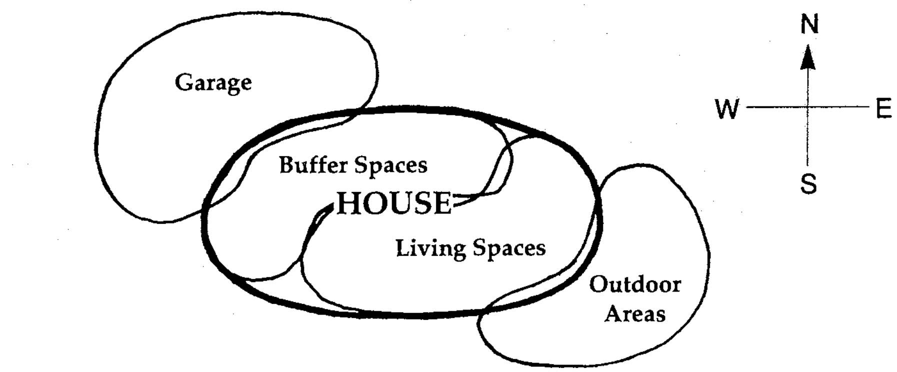


Figure 2. General guidelines for house and room layout.

Room Placement

The floor plan and room placement are other elements that can have a big impact on the energy efficiency and comfort level of a home. Just as with window placement, some room orientations are more desirable than others.

West orientations are cold in the winter and hot in the summer, while south orientations are warm in the winter and easily shaded and open to cool breezes in the summer. East orientations receive little winter sun and too much summer sun, but are protected from winter winds. North orientations are cold in winter and cool in summer.

As a result of these characteristics, rooms on the south and east will be more comfortable and easier to heat and cool than rooms on the north and west. Buffer spaces, such as garages, storage, stairs or halls, are best located on the west and north sides of the house. Figure 2 illustrates a recommended layout for a home. Primary living spaces should be placed on the south, with the majority of windows facing south, whenever possible. The east is a good location for eating areas, secondary living spaces and outdoor activities. Table 1 summarizes some general guidelines for window and room locations, although a site's view, slope or landscape constraints may not always let you follow these recommendations.

In addition to being visually appealing, a home's design should take into account the homeowner's needs in terms of efficiency, comfort, function and affordability. Homeowners should remember to start with a simple rectangle in either a ranch, split-level, split foyer or two-story design, depending on their preference and site conditions. Major living spaces should be placed to the south and east and buffer spaces to the north and west. Windows should be added to the south for winter solar heat and summer breezes, and to the east and north for additional light and cross-ventilation. Then plans can be adjusted as needed--garages, entries, rooms or windows moved--to make the home fit their individual needs.

Table 1.

GENERAL GUIDELINES FOR WINDOW AND ROOM LOCATIONS

Orientation	Sun/Wind	Window Area	Room Type
North	--/Buffer	Minimize	Secondary buffer spaces
East	Shade/--	Minimize	Secondary living spaces
South	Open/Open	Maximize	Primary living spaces
West	Shade/Buffer	Avoid	Primary buffer spaces

Recognition for Cold Climate Housing Center

The staff of the Cold Climate Housing Center received the Minnesota Extension Service "Issue Team Award" at the MES Annual Conference in Brainerd. This award recognizes an outstanding contribution by an interdisciplinary team addressing an issue important to Minnesota. The 'issue' of cold climate housing impacts the world environment, our regional economy, and the safety and longevity of the houses we live in. The 'team' responded with a wide range of educational programs to assist the home-building industry to improve dwelling efficiency with respect to economy, occupant health and safety, and extended dwelling life and to help consumers reduce service calls, repairs, and expense by providing information on creating and maintaining highly efficient homes.

Why The Bathroom Stinks *Continued from page 1.*

[ ] The bath fan was vented through the roof by the builder. She didn't like the look of a wall vent intruding on the clean lines of her gable-end siding. Whenever condensation forms in the duct, it drips down into the fan housing. The "fan that would save us money" has
[ ] a poorly-fitted damper. Small amounts of warm, moist air continually leak up into the duct, condense and drip back down onto the floor. The drywall around the fan housing is water-stained. To cover the floor stains, we put in a new bathroom carpet. The
[ ] carpet blocks the bathroom door undercut, so the "fan that would save us money" gets even less make-up air than before. The fan is
[ ] controlled by an on-off wall switch. Every weekday morning, Mom shuts off the fan immediately after her shower and gets ready for work. (If the fan was controlled by a twist timer, she could set the fan to run for a period which included a drying-out time after her shower.) To solve the moisture problem, Dad installed a dehumidistat, so the fan would operate whenever someone took a shower. Everything was fine until the night we had pork and beans for supper. The
[ ] dehumidistat doesn't sense odors, so the bathroom stunk. In summer, we open windows to catch the breeze. The outside air is humid in summer, so the
[ ] dehumidistat caused the bath fan to run all summer long. Dad solved that problem. He took out the dehumidistat and hot-wired the fan to the bathroom light switch. Now the fan operates whenever the bathroom light is turned on. But all the continuous use has caused an
[ ] accumulation of dust and grime on the fan blade. As a result, it draws even less air than before. As if that isn't enough, the "fan that would save us money" is still
[ ] too noisy. Dad has gotten fed up. He sits alone in the bathroom shadows with the light off. He thinks the fan doesn't make any difference, so he
[ ] doesn't use the "fan that would save us money" anymore.

Sheathing Choice is Critical to Wall Performance

by Charles L. Delaney, Forest Products

Sheathing that has insulating characteristics is often used in the construction of homes in Minnesota. Today, rigid-foam plastic insulation constitutes a sizable percentage of exterior wall sheathing (see Figure 1). While increasing the thermal properties of the wall, this type of sheathing has also become associated with siding problems.

Rigid-foam plastic insulation has not always been a common sheathing material. After World War II, plywood began replacing lumber as the predominant construction material used for wall sheathing (as well as floor and roof sheathing). Since then, a number of other panel products began entering the wall sheathing market, including waferboard, oriented strandboard, fiberboard, and gypsumboard. As a result of the 1970s oil embargo and the interest it brought in energy-conserving construction techniques, rigid-foam sheathing became more popular because of their high R-values (see Table 1). Types of rigid

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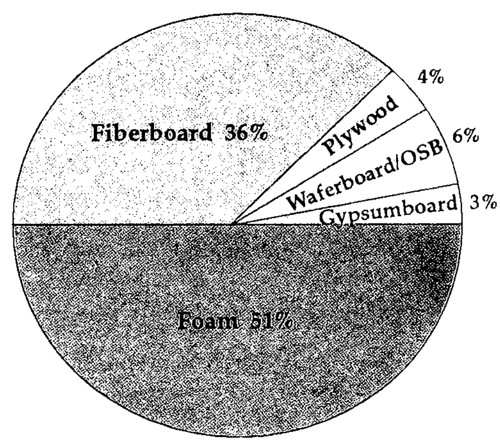

Figure 1. Exterior wall sheathing used on Minnesota single family houses - 1987.
Source: NAHB National Research Center.

Table 1.
R-Values of Common Sheathing Materials

Material	R/Inch
Gypsumboard	0.90
Plywood	1.25
Fiberboard	2.64
Molded Expanded Polystyrene "Beadboard"	3.85-4.35
Extruded Polystyrene	5.0
Polyurethane (unfaced)	6.25
Foil-Faced Polyisocyanurate	7.2

Source: 1985 ASHRAE Handbook of Fundamentals

sheathing include polystyrene (both molded expanded or "beadboard," and extruded), foil-faced polyisocyanurate and polyurethane. In addition to reducing heat loss through the walls, rigid-foam sheathing possesses a warmer inside surface temperature than non-insulative sheathing, which in turn decreases condensation formation caused by interior moisture sources. Thermal bridging through the studs is also reduced with foam sheathing.

Siding problems, particularly when exposed to direct sunlight, have been associated with the use of rigid-foam plastic sheathing. In some cases, peeling paint, cupping and warping of wood siding over rigid-foam have caused some siding manufacturers to withdraw their guarantee when the product is installed over foam sheathing. The sheathing's impermeability to moisture is believed to cause the problem. Rain water that is wicked up behind the siding becomes trapped between the water-impermeable sheathing and the siding. The back of the siding then absorbs the moisture and swells, while the front of the siding dries due to exposure to the sun. This results in a *moisture gradient* which imposes stress on the siding. This stress can lead to the warping, cupping and peeling paint. A technique which may alleviate this problem involves installing the siding on furring strips, which provides an air space between the sheathing and the siding and allows the moisture to escape.

Before selecting a sheathing material, it is important to consider all aspects of the total wall system. The material's insulating and permeability characteristics must be carefully evaluated in relation to the siding choice. In this way, the wall system can achieve its best performance.

References:

ASHRAE Handbook of Fundamentals. 1985. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., Atlanta, GA 30329.

National Association of Home Builders National Research Center. *Summary From Annual Builder Practices Survey*. National Association of Home Builders National Research Center, Upper Marlboro, MD 20772-8731.

Lstiburek, J.W. 1987. *Applied Building Science*. Building Engineering Corporation. Downsview, Ontario, Canada. pp. 38-53.

Miller, Charles. 1989. (Oct./Nov.) "Thermal Insulation." Fine Homebuilding, pp. 36-43.

Important Points On Kitchen Ventilation

by Wanda Olson, Design, Housing and Apparel

The kitchen ventilation system is an integral part of total home ventilation. The system should exhaust rather than recirculate air, and operate quietly so that it will be used. It is also important to balance the exhaust airflow with fresh air to prevent backdrafting of any naturally vented furnaces and water heaters. Below are some points to consider when choosing an appropriate exhaust system for your kitchen.

* The exhaust system should be run whenever moisture, gases, or odors are being generated (cooking, making coffee, dishwashing, etc.).

* Systems should have a minimum airflow rate of 100 cubic feet per minute (cfm). Downdraft units and some hoods have airflow rates higher than 250 cfm, but are difficult to install because they require large amounts of fresh air to balance the exhaust flow. A low-flow (25 cfm) continuous exhaust may be used if integrated with a central ventilation system for the entire home.

* Above-range hoods are more effective than central exhaust systems with registers in the ceiling or soffit.

* With gas ranges, hood or downdraft exhaust units should be used to exhaust combustion gases.

* The range hood should extend over most of the cooking surface.

Continued on page 8.

The House Doctor

The intent of this column is to discuss issues or problems currently being encountered by contractors, builders and consumers in building and maintaining homes in cold climate regions.

Siding Moisture Problems

by Timothy D. Larson & Patrick Huelman, Forest Products

This past spring the Cold Climate Housing Center received a call from a homeowner in the northern suburbs of the Twin Cities complaining about a lap siding failure. Figure 1 illustrates the problem which included several dark streaks beginning at the laps in the siding. The streaks could be washed off in the late spring but the homeowner didn't feel this chore should have been necessary in a new home. Also, the homeowner was concerned about the siding's durability.

The wall was constructed of the following sequence of material (beginning from the inside): drywall, polyethylene, 2x6 (with R19 fiberglass) studs, fiberboard sheathing and hardboard lap siding (see Figure 1).

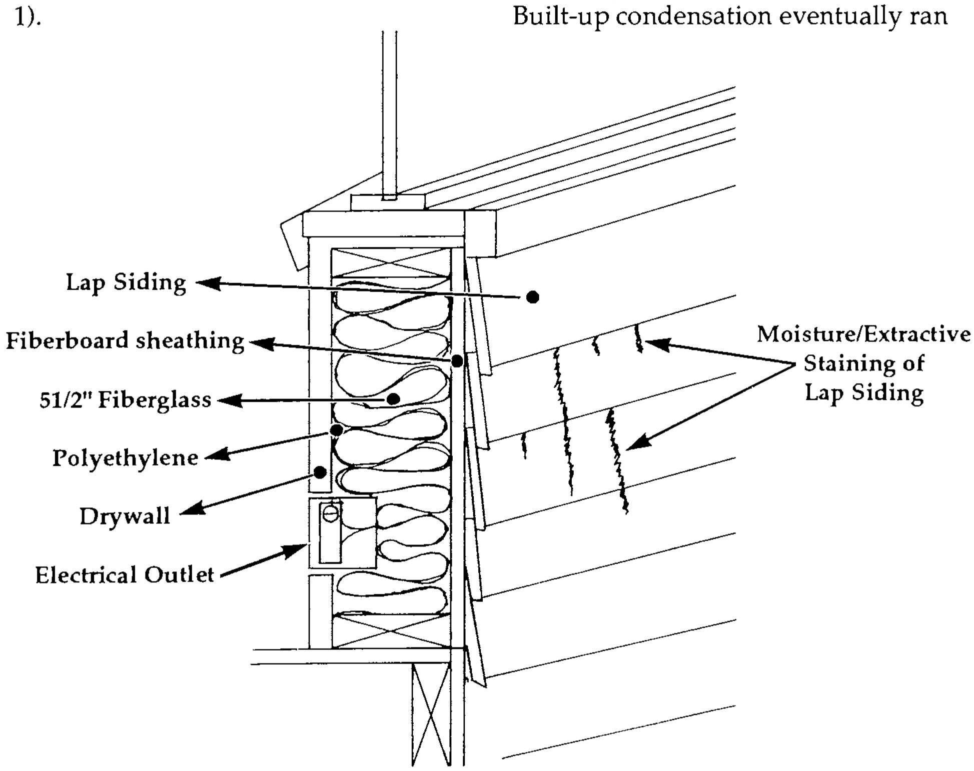

Figure 1. Moisture (extractive) staining of lap siding.

The homeowner noticed that the streaking appeared in the late fall, before the temperature dropped below freezing, and in the late spring. This strongly suggested that the moisture which was picking up extractives from the fiberboard sheathing or siding on its way out was coming from inside of the house.

While some of the moisture was moving by diffusion, most of it was probably moving through the wall by air movement. As the warm moist air moved through the wall it cooled and reached the dew point before it exited. Once it reached the dew point, it condensed in the wall as liquid. The point where the sheathing and siding interface was a likely spot for this condensation. Built-up condensation eventually ran out where the siding over-lapped. Figure 2 illustrates the two ways moisture moves through a wall in winter and locates the area where condensation may take place. For simplicity, the figure localizes diffusion to show its movement even though it actually takes place throughout the exterior wall.

If a vapor retarder (e.g., polyethylene) has been properly installed or applied, moisture movement by diffusion would be small and should not contribute to moisture problems in the wall cavity or at the sheathing/siding interface. In addition to the proper installation of a vapor retarder, the air flow through the exterior wall and ceiling at points such as the electrical outlet and window/wall joints (see Figure 2) must be eliminated. The wall must have an air barrier to prevent air flow across the wall. The vapor retarder (polyethylene) can serve as the air barrier but it must be continuous and sealed. It is primarily air flow out that has led to the homeowner's siding problem.

Controlling interior humidity levels (20 to 40% depending on outside temperature) by managing moisture production and removal could also aid in minimizing moisture problems.

The homeowner had tried to reduce relative humidity and window condensation by replacing a four-inch air intake to the furnace room with a seven-inch intake connected directly to the cold air return.

Continued on next page .

Although this measure did lower the relative humidity in the house it raises two important questions.

1.) Where is the moisture now going?

2.) Where is the air going out?

There was a strong possibility that this house was positively pressurized because the fresh air intake was now attached to the cold air return and no measures had been taken to balance the incoming air with exiting air. The positive pressure could then push the warm moist air from inside the house through cracks and holes in the exterior walls and the ceiling. During the winter or heating season this contributed to condensation in the building envelope and eventually to moisture problems.

It was interesting to note that the homeowner's garage, which had a wood stove that was rarely used, had the same siding problem. The garage windows had condensation/frost problems. This indicated that the inside of the garage was generally warmer than the outside and that there was some source of moisture. If the house was being pressurized, the bypasses between garage and house could have allowed warm moist air to enter the garage.

There was other evidence of items contributing to the siding moisture problem. For example, there was a 25-foot run of dryer-vent ducting, of which half was flexible duct containing a few holes. It would be safe to say that with such a long duct run creating a high resistance to air flow and a ducting system that was not airtight the dryer was venting some of its moisture back into the house.

It was also noticed that the bathrooms in the house were fairly airtight. This meant that if the bathroom door was closed during the shower or bath, the fan's capacity to remove moisture was greatly diminished because of a **lack of make-up air.** The bottom of the bathroom door would need to be trimmed, or a louver placed in the door, to allow make-up air into the bathroom. This would allow the fan to work more effectively.

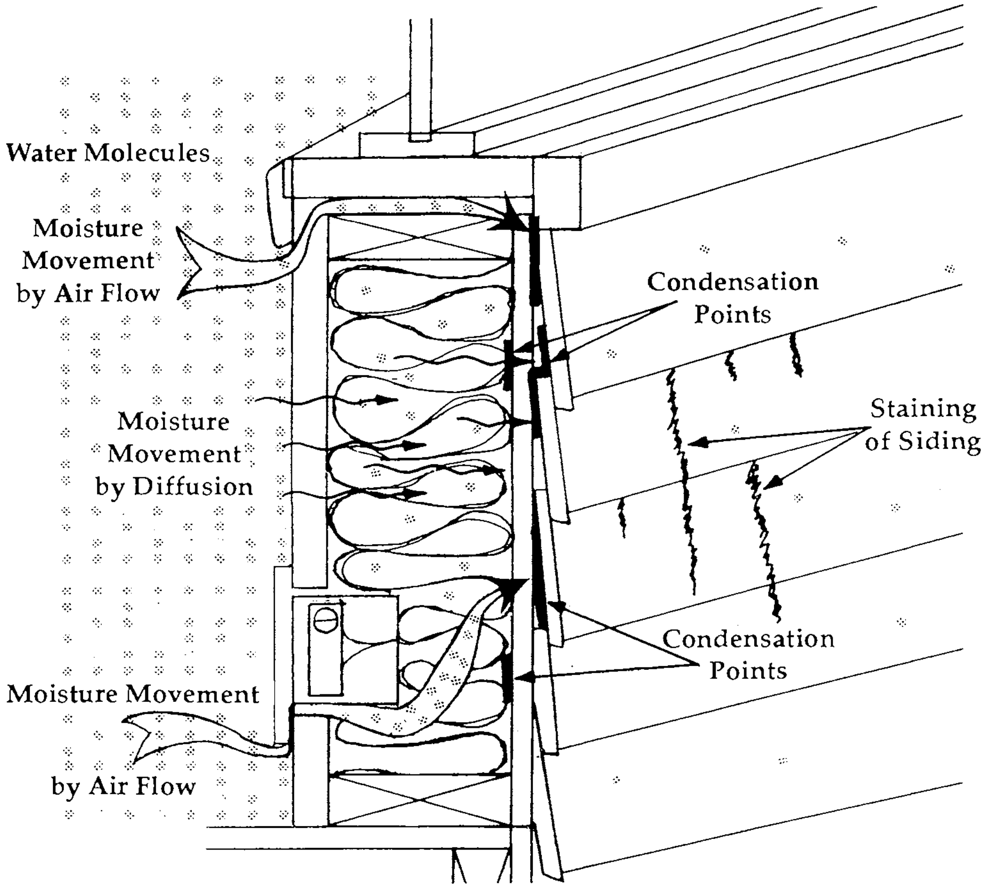

Figure 2. Moisture movement through an exterior wall.

Finally, the house was relatively new and construction moisture could still have contributed to a moisture problem.

The recommendations to this homeowner included the following:

1.) Disconnect the fresh air ducting from the cold air return and drop it into a bucket next to the furnace and water heater to provide combustion air.

2.) Make sure there is adequate make-up air for the bathroom exhausts.

3.) Replace and reduce the 25-foot dryer duct length (or increase the duct diameter) to cut down on the resistance to air flow and to eliminate the holes.

4.) Seal all possible spots for air flow through the exterior wall such as electrical outlets and plumbing penetrations under the kitchen sink.

5.) Check for backdrafting of all combustion appliances because the fresh air duct next to the furnace might not have the capacity to provide both combustion air and make-up air for all the devices in the house. Besides a clothes dryer, bathroom exhausts and kitchen exhaust, the house had a fireplace on the first floor and a wood stove in the basement. All of these devices needed air intake during operation.

If the homeowner continued to have moisture problems after taking the above recommended steps then a ventilation strategy needed to be developed to bring fresh air in and remove moist stale air in a **controlled** fashion. A house in a cold climate should neither be positively nor negatively pressurized on a continuous basis. Instead the pressure difference between the inside of the house and the outside should be minimized.

Important Points on Kitchen Ventilation

Continued from page 5.

* The level of noise produced by the system should be considered. Some range hoods operate at as low as 2.5 sones at the high speed, while most hoods and downdraft units are rated between 4 and 7 sones. (Refrigerators operate at about 1.0 sone.)

* Before adding an exhaust system, it should be determined if it will create backdrafting of any naturally vented combustion appliances elsewhere in the home (e.g. furnace, water heater, fireplace).

Questions? Comments?
For more information:

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Are you moving? If so, please send your name and new address to CCHC. Thank you.

Cold Climate Housing Publications

"Home Moisture Sources," Fact Sheet CD-FS-3396.

"Mold and Mildew in the Home," Folder CD-FO-3397.

"Home Indoor Air Quality Assessment," Folder CD-FO-3398.

"Residential Heat Loss," Folder CD-FO-3399.

"Insulation Basics," Folder CD-FO-3400.

"Moisture Sources Associated with Potential Damage in Cold Climate Housing," Folder CD-FO-3405.

"Home Indoor Winter Relative Humidity: What is Acceptable?" Folder HE-FO-3415.

"Radon Issues in House Buying and Selling," Folder HE-FO-3532.

"Radon Facts for House Sellers and Buyers," Fact Sheet HE-FS-3533.

"A Systems Approach to Cold Climate Housing," Folder CD-FO-3566.

"Humidity and Condensation Control in Cold Climate Housing," Folder CD-FO-3567.

"Ceiling Airtightness and the Role of Air Barriers and Vapor Retarders," Folder CD-FO-3568.

"Exterior Wall Airtightness and the Role of Air Barriers and Vapor Retarders," Folder CD-FO-3569.

"Performance of Downdraft Kitchen Range Exhaust Systems," Folder HE-FO-3722.

"Performance of Kitchen Range Exhaust Hoods," Folder HE-FO-3713.

"Radon Reduction in Cold Climate Houses: Preliminary Perspectives," Bulletin HE-BU-3818.

"Radon and New House Construction," Folder HE-FO-3819.

"Residential Kitchen Ventilation," Folder HE-FO-3725.

"Minnesota Radon Facts," Fact Sheet HE-FS-3882.

Two video tapes on range exhaust systems are available through the Extension Distribution Center, 3 Coffey Hall, 1420 Eckles Avenue, St. Paul, MN 55108. They are "Performance of Kitchen Range Exhaust Systems" (HE-VH-3593) and "Kitchen Range Exhaust System" (HE-VH-3594).

Several other Cold Climate publications are currently being prepared, reviewed or planned. By writing or calling your local county extension agent or the Cold Climate Housing Center, you can obtain single copies of the publications listed above. Additional copies of the listed publications can be purchased from the Extension Distribution Center on the St. Paul Campus. Fact sheets are priced at 10¢ wholesale, 20¢ retail, while Extension folders are priced at 25¢ wholesale, 50¢ retail.

During the coming year, CCHC staff will be conducting educational programs in many subject areas related to cold climate housing. A Cold Climate "Central" telephone number--612-624-9219--has been set up in Kaufert Laboratory (Forest Products) on the St. Paul Campus. Incoming calls regarding the program and information requests may be directed to this number or to specialists serving particular subject matter areas.

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"The financial support of Exxon Oil Overcharge funds administered by the U.S. Department of Energy and Minnesota Department of Public Service, Grant Number DE-F602-76CS60014 is acknowledged, but the authors assume complete responsibility for the contents herein."