Cold Climate Housing NEWS

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Minnesota Building Research Center, University of Minnesota

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Spring Preview Project Reveals High Interest in Energy Efficient Housing

Bruce D. Nelson, *Senior Engineer*
Minnesota Department of Public Service, Energy Division

Introduction

Two Twin Cities builders have changed the way they are building houses, and the rest of the world is taking notice. This spring's metro area Preview of Homes featured two of their homes and many people came to see their innovative approaches to indoor air quality and energy efficiency.

The construction of these two homes was, in part, an on-site builder workshop project initiated by the State's Department of Public Service (DPS). The substantial public attention that the project received would seem to indicate the public's interest in energy efficient construction employing controlled ventilation.

The project began as a new approach to builder education. In recent years, Minnesota builders have had more opportunity to participate in classroom education. However it isn't clear whether or not this classroom experience transfers directly to job performance. Instead of a classroom setting, the new approach involved workshops at the building site of an energy efficient house. At the site, blower door and infrared scanner equipment could be used to demonstrate the effectiveness of improved construction techniques.

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Demonstration Home Features Cold Climate Housing Details

***Teddi Barron**, Forest Products*

When Minnesotans toured the energy-efficient demonstration home in Burnsville this spring, they saw a stylish new house not unlike others displayed in the Preview of Homes. Underneath the finishes, however, were "hidden details" that made the house unique. And with the help of a video program, visitors were able to see the invisible features of the home's air-tight construction and state-of-the-art ventilation.

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Spring Preview Project *Continued from page 1.*

Two Approaches

There is usually no single right answer when it comes to building a home. The DPS project was fortunate enough to involve two solutions to the problems of managed ventilation and air-barrier envelope systems. Both homes were fitted with high performance windows and set up for possible radon mitigation, should that be found to be needed. In addition, two design assistance teams, along with the Cold Climate Housing Center staff, worked with two separate builders to construct model homes with each approach.

The first approach was assisted by energy expert, Gary Nelson, and planner, David Nelson. A Chicago builder, Perry Bigelow, was chosen for the project. Bigelow builds for the moderately priced housing market and guarantees annual heating bills under $200. The Bigelow concept incorporates an airtight-drywall approach (ADA), a single-unit combination space-domestic water heating system and a continuously operating exhaust-only ventilation system.

Meridian Homes of Coon Rapids was enthusiastic about the Bigelow approach. They built a model in Andover next to a home with nearly identical floor plan but of standard construction so the two could be contrasted in the builder training. The Minneapolis Builders Association provided special publicity for the Preview of Homes. John Feges, president of Meridian Homes, was very pleased with the cooperation provided by his subcontractors who had never before installed an ADA system. The local building official was also quite cooperative, even though some elements of the design represented a significant departure from traditional practice.

The second approach was assisted by Joe Fischer of Builders Insulation Co. and Mark LaLiberte of Shelter Supply. An airtight vapor barrier system, a specialty of Builders Insulation Company, was installed. Balanced ventilation was provided by an air-to-air heat exchanger.

Hans Hagan Homes, who had installed Builders Insulation's air barrier system in homes before, agreed to conduct this demonstration project on a home in Burnsville. The Metro East Professional Builders Association coordinated the builder workshops and Preview publicity for the demonstration. The Burnsville home airtightness was tested at 0.7 air-changes-per-hour at a 50 pascal pressure differential.

Educational Value

Several workshops were conducted at the two sites in March, April and May for builders, sub-contractors, and building officials. As evidenced by the number of inquiries about these approaches, the workshops were successful in explaining the potential benefits of the improved construction practices. But education of the building trades was not the most significant impact of the project.

A special write-up on these homes in Spring Preview newspaper insert, combined with significant radio and TV coverage, generated an enormous amount of home buyer interest in the demonstration houses. The public reaction was outstanding. Although no statistics are available to compare, these homes had substantially higher traffic during the Preview. There is obviously a large buyer interest in energy efficient housing and controlled ventilation.

Long Term Impact

Both Meridian and Hans Hagan Homes have realized construction technique and marketing gains from their participation in this project. Meridian has completely switched its basic design and is now only offering the energy efficient-continuous ventilation model. Hans Hagan Homes has made demonstration-home features standard, and are offering the rest as options on all of their homes.

The Energy Division will be studying the energy and air quality performance of these two homes for at least the next year, and while the small sample size will not permit many generalizations, this project has already succeeded in identifying a new trend: an increasing consumer interest in energy efficient and controlled ventilation. Builders would be wise to keep in tune with this discovery. ■

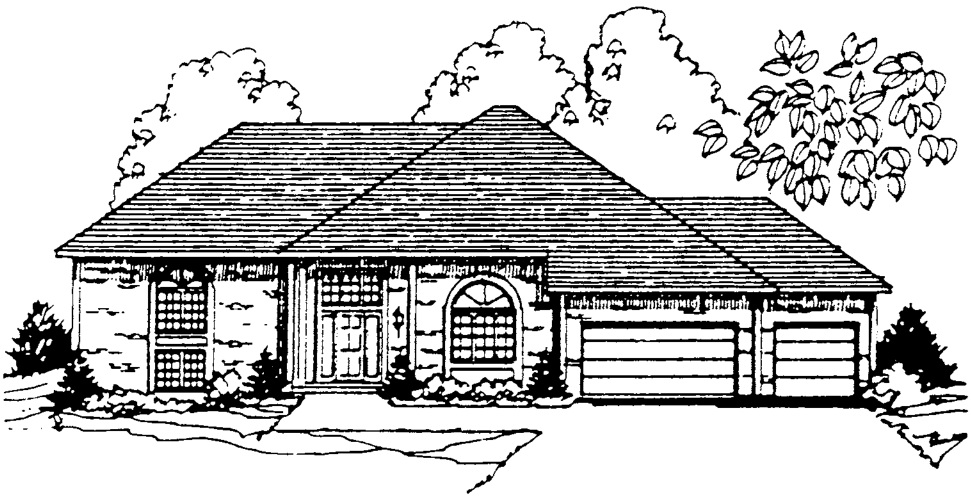
Demonstration Home

Continued from page 1.

The video was one of the Cold Climate Housing Center's (CCHC) contributions to the demonstration home project which was initiated by the Department of Public Service's (DPS) Energy Division. Other CCHC efforts included technical assistance in the design and construction phase of the home, participation in two builder workshops and a public open house, and distribution of publications and other educational materials.

Video Reveals Details

The 12-minute video program, "Building Blocks of Cold Climate Housing," aired continuously during the 15-day open house. It shows many of the construction methods and materials used to increase energy efficiency and prevent excess moisture and indoor air contamination in the demonstration home. The program also explains the importance of the systems approach in building homes that are energy efficient, comfortable, durable, and healthy.



Hans Hagan Homes' Spring Preview Model in Burnsville incorporated energy efficient construction techniques recommended by CCHC specialists.

Among the features highlighted in the video are the radon reduction system, the energy truss, the continuous air/vapor barrier, special airtight sealing techniques, the heat recovery ventilator, and the sealed combustion furnace and fireplace.

Technical Guidance

During the design and construction phases of the demonstration home, CCHC specialists provided technical assistance to builder Hans Hagan. For example, they worked together to find a detail that would "pull in" the rim joist and allow insulation to be placed on the exterior. The specialists also helped evaluate state-of-the-art radon reduction techniques and promoted the installation of a sealed combustion fireplace to avoid the potential for dangerous back-drafting.

On-site Education

Midway through the construction process, two builders' workshops were conducted on the site. More than 50 builders participated in the half-day training sessions. CCHC Coordinator, Pat Huelman, provided instruction on energy efficient and airtight homes using installations at the site as examples. Other instructors were Joe Fischer of Builders Insulation Company, Mark LaLiberte of Shelter Supply, Inc., and Elroy Berdahl of the State of Minnesota's Building Codes and Standards Division.

An open house for the public also was held while the house was under construction. As visitors toured the unfinished house, CCHC specialists were on hand to discuss its airtight construction and ventilation system.

CCHC educational support materials were distributed during the special events at the demonstration home. In addition to a new tabletop display which introduced the Center and illustrated the systems approach, publications on energy-efficient construction, moisture control, and indoor air quality were provided to builders and the public.

In addition to DPS and CCHC, cooperators on the demonstration home project included the American Lung Association, Builders Insulation Company of Minneapolis, Hans Hagan Homes, Professional Builders Association-Metro East, and Shelter Supply, Inc. ■

The Cold Climate Housing Center (CCHC)

is an interdisciplinary group that draws its technical expertise from three departments at the University of Minnesota: **Agricultural Engineering; Design, Housing, and Apparel;** and **Forest Products.** Throughout the year, the CCHC staff will be conducting educational programs in many subject areas related to cold climate housing. Questions regarding these programs and other information that is available through the Center can be directed to CCHC's central telephone number: **(612) 624-9219**. Technical questions will be forwarded to one of our specialists in the appropriate subject area.

Cold Climate Housing News is a publication of the Minnesota Extension Service. All requests to reprint or abstract any portion of this newsletter must be submitted in writing to the Cold Climate Housing Center.

If you have questions or comments regarding this newsletter, contact:

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Are you moving or receiving duplicate mailings? Please send your name and address, or any corrections, to the address above.
Thank you.

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.

Summer Cooling Problems?

***Patrick Huelman**, Forest Products*

Have you received call-backs or complaints from clients having a hard time keeping cool in their home? There may be many factors contributing to the problem. For example, the cooling equipment may be too small or too large, the distribution system may be improperly designed, or the cooling load - the amount of cooling needed - may be too high. In fact, many cooling complaints are a result of the cooling load associated with windows.

Both windows and glass doors play a big role in summer comfort. If they are not properly planned and selected, they can contribute to severe discomfort. Windows serve two important comfort functions. First of all, operable windows let inside air out and cool outside air in. In fact, even warm air flowing over our skin will provide cooling due to evaporation of perspiration. The window's role of natural ventilation should be considered when deciding its orientation, location, type, and size.

Secondly, a fixed or closed window provides a modest barrier to heat gain and solar radiation into the building. Windows generally make up one-third to one-half of the cooling load for a home. For this reason, window placement should be planned carefully. While windows need to let the breezes in, they also need to keep the heat and sun out.

Keeping the Heat and Sun Out

Conductive Heat Gain

Heat gain by conduction is a function of the window u-value - the lower the u-value the lower the heat gain. (Note: The reciprocal of the u-value will yield the r-value.) Therefore, lowering a window's u-value will reduce summer heat gain.

For new windows, this can be achieved by selecting windows with low emissivity coatings, low conductivity gas (e.g. argon) between the panes of sealed glass units, or multi-pane glazings. When evaluating these windows make sure you compare the total window unit u-value and not just the center-of-glass u-value. The center-of-glass u-value may be considerably lower than total window values (see Table 1). For existing windows, the u-value can be lowered with the addition of another glazing layer (either glass or plastic) as an interior or exterior panel. This lower u-value will provide even greater winter savings by reducing heat loss from inside the home as well.

Solar Heat Gain

In addition to the window's u-value, the solar heat gain factor or shading coefficient determines solar heat gains into the home. The higher the shading coefficient, the more solar radiation and less shade is provided (see Table 1). Reducing solar radiation can be difficult because approximately 50 percent of the solar radiation is due to visible light. So, completely preventing solar heat gain would also eliminate views to the outside. However, some coatings or additional glazings can

Table 1. Properties of typical windows.

				Summer U-Value		
	e[b]	# of Coated Surfaces	Gas Fill	Center-of-Glass	Overall Unit[c]	Shading Coefficient[d]
Double Glazing[a]	-	-	-	0.57	0.54	0.91
	0.40	1	-	0.49	0.49	0.86
	0.15	1	-	0.40	0.43	0.75
		1	argon	0.33	0.39	0.75
Triple Glazing	-	-	-	0.40	0.43	0.82
	0.15	1	-	0.31	0.38	0.68
			argon	0.26	0.35	0.68
		2	-	0.25	0.34	0.57
			argon	0.20	0.31	0.57

[a] All window products have 3/8" spaces between glazings.
[b] e = the emmisivity of coatings on the inner between-pane glazing surface(s).
[c] Overall unit u-value assumes residential-sized window with wood frame and aluminum edge spacer.
[d] Shading coefficient = (SHG of product) ÷ (SHG of single pane clear glass).
(Note: SHG is solar heat gain)

Source: Calculated using WINDOW 3.1 computer program.

slightly reduce solar radiation without adversely blocking the visible light and view. Another problem involves the fact that window products that reduce solar gain in the summer will generally reduce the beneficial solar heat gain in the winter as well. Although this could change in the future, switchable window technologies are not likely to enter the residential market for many years. At this point in time, proper window orientation and placement along with shading devices, landscape features, and seasonal shading with screens and awnings are the best approaches for substantial reductions of summer solar radiation while maintaining valuable winter solar heat gain.

Window Orientation. The direction that a window faces will have a direct impact on solar heat gain. For example, summer solar heat gain on east and west windows will be almost twice that for south windows. A west-facing standard, double-glazed patio door will require more than one-half ton (one ton = 12,000 Btus/hr) of air conditioning just to remove unshaded solar heat gains.

Window Placement. This refers to strategic window location relative to exterior shading and interior room configurations. Groups of windows will generally be easier to shade than a number of individual units. Also, high windows are easier to shade with overhangs and the heat gains tend to be dispersed throughout the room.

Shading Devices. Exterior shading devices are much more effective than interior treatments. A fully shaded window will reduce solar heat gain by as much as 80%. On south windows, a small overhang (approximately 2 feet for a typical 4-foot tall window) will cut summer solar gains in half. However, overhangs are not very effective on east and west orientations because the summer sun is low in the morning and afternoon sky. Adjustable or removable shading devices can be very effective but require faithful management to remain beneficial.

Seasonal shading products for the exterior such as solar screens, special woven fabric, and metallic or plastic mini-louvers can be very helpful for reducing solar heat gains on problem windows. These products have shading coefficients ranging from 0.10 to 0.45 for louvered sun screens (depending on louver shape and color) when applied over double glazing, and are especially appropriate to improve the performance of existing windows.

Trees and other landscape features such as a trellis, arbor, shrubs, and vines can have a major impact on summer cooling by shading adjacent windows. The farther you go from the house or window being shaded the greater the height and number of trees you will need (see Figure 2). Short trees and shrubs close to the home will generally be more effective for shading east and west windows. Remember to make provisions for valuable winter solar radiation to reach the home. For this reason, deciduous trees are usually recommended for shading purposes. However, even deciduous trees should be carefully evaluated when used on the south side of the home. The winter solar heat gain lost due to shading by the trunk and bare branches is likely to exceed the summer savings.

If exterior shading devices or products and landscaping are not possible, interior treatments can provide some relief if they are properly selected and managed. For example, it is important to pick a product with a white or reflective backing and a tight weave (see Table 2).

Natural Ventilation

Even though the majority of this discussion has emphasized ways to minimize the negative impact of windows on summer comfort, the importance of cooling with natural

Continued on page 6.

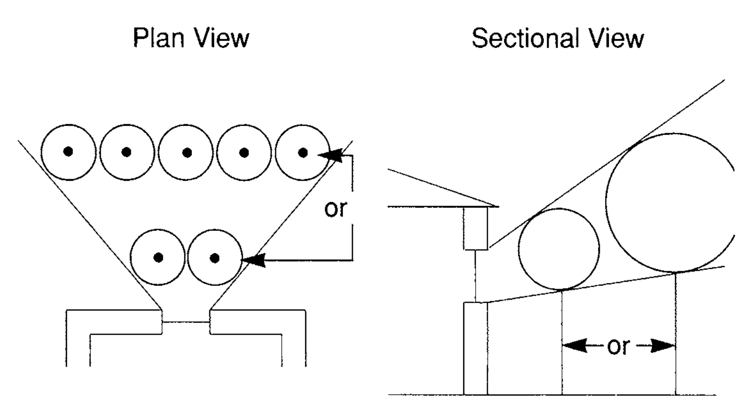

Figure 2. Using landscaping to shade east and west windows.

Table 2. Shading coefficients for various window treatments with double glazing.

Venetian Blinds	Medium Color		0.57
	Light Color		0.51
Roller Shade	Opaque	Dark Color	0.60
		White Color	0.25
	Translucent, Light Color		0.37
Draperies	Open Weave, Low Reflectance		0.80
	Tight Weave, High Reflectance		0.35

Source: ASHRAE handbook of fundamentals.

Summer Cooling Problems?

Continued from page 5.

ventilation should not be underestimated. Of course, this approach only works if breezes are able to reach and flow through the home and the cooling loads have been minimized. Window orientation and placement, interior layout, and landscape design should maximize the potential for natural ventilation.

With good window placement and selection; attention to natural ventilation; and sufficient insulation, airtightening, and occupant management a home can be comfortable without air conditioning for all but a few days a year. ■

References:

American Society of Heating, Refrigeration, & Air-Conditioning Engineers. 1985. ASHRAE handbook of fundamentals. Atlanta: ASHRAE, Inc.

WINDOW 3.1 - a PC program for analyzing window thermal performance. 1988. Computer software. Berkeley, CA: Lawrence Berkeley Laboratory.

Huelman, Patrick. 1990. Energy-efficient housing requires early planning. Cold Climate Housing News 3 (1), Winter. Saint Paul: Cold Climate Housing Center, University of Minnesota.

Minnesota. Department of Public Service. Energy Division. 1989. Summer comfort. Saint Paul: Minnesota DPS.

Editor's Note:

*Due to limited space, Part 2 of the three-part series, "Energy Efficient Swedish Housing" has been rescheduled and will appear in the next issue of **Cold Climate Housing News.** This article discusses some of the construction details that contribute to the high levels of energy efficiency in Swedish factory-built homes. Look for it in the fall issue due out in November.*

Guidelines for a Healthy Home

Stan Wrzeski, CCHC Housing Technology Consultant

People frequently ask us, "What is the best way to build a home?" It's a tough question. The ideal must be reconciled against the practical...and there's always the question of economics.

As part of an effort to provide an answer, we are developing guidelines for new residential construction. Our first set of guidelines covers indoor air quality (IAQ) issues.

Homes constructed according to these guidelines should be healthy homes. There should be no complaints of odors or stale air. Moisture won't be dripping from windows. Chimneys won't downdraft. Radon levels can be controlled.

For these guidelines to work, a broader strategy is needed to clarify lines of responsibility between the builder and the homeowner. The builder is responsible for constructing a home in which occupants can control their indoor air quality. Then the occupants are responsible for properly operating and maintaining these systems. If either fails to do their job, the home may have IAQ problems.

The guidelines are being circulated for review among experts around the country. **We'd like to know what you think.** Are the recommendations practical?

When we've received comments and revised the guidelines, we'll develop supplementary materials explaining how builders can easily design these features into their homes.

Your comments can be sent to:

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1985 Buford Avenue
St. Paul, MN 55108

Minnesota Building Research Center

Design Guidelines for Residential Construction: Indoor Air Quality

I. Ventilation of Living Spaces

A. Air Flows

1. The ventilation system(s) of a home should be capable of delivering the following minimum cubic feet per minute (cfm) while all other exhausting appliances in the home are operating with the home closed under winter conditions:
   - **a.** continuous ventilation at a rate of .35 air changes per hour, but not less than 15 cfm for each person in the household;
   - **b.** local, intermittent exhaust ventilation of at least
     - 50 cfm in the bath
     - 100 cfm in the kitchen, via a range hood or range downdrafting ventilator.
2. Any exhausting of greater than 250 cfm must have a dedicated make-up air opening.
3. In homes without forced-air heating/cooling systems, the ventilation system should distribute make-up air (fresh air) to rooms that do not have exhaust ventilation.

B. Controls

1. The bathroom ventilator should be controlled by a timer that can be set for 30 minutes or more.
2. Controls are usually "built in" to the range ventilation appliances; if separate controls are feasible, install a 60-minute timer.
3. The continuous ventilation

should be operated by two controls wired in parallel:

a. a dehumidistat placed in a central hall or family room, adjacent to the thermostat; and

b. a clock timer mounted in the basement, to operate the system during typical periods of occupancy.

II. Ventilation of Combustion Appliances

A. Space- and water-heating equipment which burns fossil fuels should be closed combustion or sealed-combustion (direct-vent).

B. Fireplaces should have well-sealing doors and outside combustion air ducted directly to the firebox.

III. Radon Reduction

There is no way to predict whether a particular construction site will have radon problems.

A. During construction:

1. Install a stone aggregate bed under the floor slab, so sub-slab ventilation may be retrofitted at a lower cost (if necessary after testing).
2. If the home has perimeter drainage collected at a sump, install a sump with well-sealing cover; if the home has no sump in the basement, install a capped 4" PVC stub pipe through the floor slab.

B. After construction is completed, the builder must install two sensors at the lowest level of the home as follows:

1. one charcoal canister detector to provide early evidence of high radon levels; and
2. one alpha track detector to monitor long-term exposure during the first year of occupancy. The homeowner should be given the return mailer and be instructed to forward the sensor for analysis.

IV. Material Selection

A. Avoid carpeting the floors of kitchen, bath, entry halls, or other areas subject to periodic dampening.

B. Seal the face and edges of exposed particleboard on the inside of cabinets and on any exposed shelving.

V. Thermal Envelope Details

The thermal envelope must be designed and installed such that the home can be operated under the following conditions without causing condensation on or within any component of the thermal envelope:

A. an indoor air temperature of 70 degrees Fahrenheit; and

B. not less than 25% indoor relative humidity for the ASHRAE 97.5% design temperature. ■

New Pricing Policy for Cold Climate Housing Publications

The Minnesota Extension Service, which includes the **Cold Climate Housing Center**, has adopted a cost recovery policy for its publications. The new pricing policy is being implemented to help cover rising printing and mailing costs, and to maintain the quality of educational materials.

The general public may continue to request publications from their local county extension offices. While many single-page fact sheets will remain free of charge (when obtained at extension offices), other materials will be priced according to different categories. (Minnesota libraries are eligible to receive wholesale prices.)

The CCHC will no longer be directly processing orders but will still be available to answer questions about particular publications. Orders can be sent directly to the Extension Distribution Center (see page 8 for a list of publications and ordering information).

Indoor Air Quality Symposium

The Cold Climate Housing Center is cooperating with various other organizations for a symposium entitled **"INDOOR AIR QUALITY: Synthesizing the Issues and Educating the Consumers."** Scheduled for October 15-16, 1990 in St. Louis, Missouri, this symposium is being sponsored by the American Association of Housing Educators, the U.S. Environmental Protection Agency, and Union Electric of St. Louis.

The symposium will address health, liability, risk assessment, and emerging policy/technology issues in residential structures. In addition to presentations by noted speakers in the air quality field, there will be a poster/share session, and opportunity to visit with professionals in the field of indoor air quality.

Among the featured speakers will be **Thad Godish** of the Indoor Air Quality Research Lab at Ball State University, **Terry Brennan** of Camroden Associates, **Harriet Burge** of the University of Michigan, **Laura Oatman** of the Minnesota Department of Health, and the Cold Climate Housing Center's **Stan Wrzeski**.

The symposium should be of special interest to educators, researchers, builders, real estate agents/developers, building inspectors, energy advisors, home product developers, and others concerned with the quality of air within homes. Participants will gain a better understanding of indoor quality issues, potential solutions, and how to communicate these to the general public.

For more information contact: Dr. Sandra Zaslow, Box 7605, North Carolina State University, Raleigh, NC 27695, 919-737-2770 or Dr. Joseph Laquatra, Dept. DEA, 3M13A MVR Hall, Cornell University, Ithaca, NY 14853, 607-255-2145. ■

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HE-BU3818-E	Radon Reduction in Cold Climate Houses		2.00	
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