#4541

NORTHERN BUILDING SCIENCE

VOLUME 3, NO.3 JUNE 1990

THE NO. B. S. NEWSLETTER OF THE ALASKA CRAFTSMAN HOME PROGRAM

Finding and Fixing Hidden Air Leaks

By Dave Brook, Energy Extension Agent

Most publications about weatherization still recommend caulking exterior siding and weatherstripping doors and windows to prevent drafts. In some cases these measures may increase your comfort slightly by reducing drafts coming through exterior walls, but they probably won't save as much energy as most energy audits estimate. This is because in many homes a great deal of air escapes through hidden interior air leak passageways which are not affected by typical exterior caulking and weatherstripping efforts.

Because there are numerous paths for an air leak to follow once it is inside the wall or ceiling of a home, sealing the source of the air leak from inside the home is more effective than trying to seal it from the outside. Also, it is easier to find and fix hidden air leaks working from the inside because cracks and holes are accessible. And because the work can be done indoors, you do the work in the middle of winter when the heat loss is the greatest. To understand why the standard exterior caulking and weatherstripping recommendations are likely to be ineffective, you need to understand what causes air leakage in homes.

What Causes Air Leaks?

Air will not move through a hole in a wall or floor without a driving force. One of the most powerful driving forces in winter is the stack effect - convection currents of hot air rising. Rising warm air will"exfiltrate" or pass out of the house through any crack or hole in the ceiling. Then cooler outside air "infiltrates" into the house around cracks and holes near the foundation. Plumbing and electrical wiring holes and shafts, interior partition walls that open into the attic, floor joists, and foundation areas all provide unintended and hidden air leakage passageways in homes (Figure 1). Older "balloon-framed" houses with framing running the full height of the structure have many more air leak possibilities than do newer platform-framed houses whose walls only extend up one story.

The greater the difference in temperature between warm indoor air and cooler outdoor air, the more air that is moved by the stack effect. When the outside temperature is 0•F and inside is 68•-70•F, the stack effect may move as much air as a kitchen range hood left running continuously. This results in areas of higher pressurization near the top of the house and depressurization near the bottom of the structure.

Around the mid-level of a house, the so-called "neutral pressure zone," comparatively little stack effect-driven air leakage in or out of the house occurs. In this area of the home another driving force of air leakage is sometimes noticeable - drafts resulting from windy outdoor weather. Typical caulking and weatherstripping measures, such as door and window weatherstripping, effectively reduce this wind-driven air leakage.

In a few instances hot air rising in homes is desirable. Chimney flues of fireplaces,

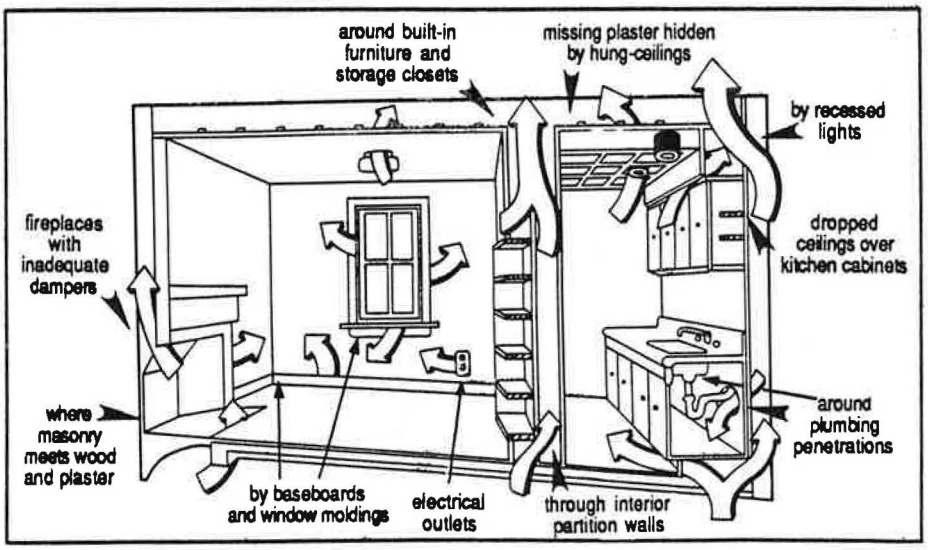

Figure 1. Common interior air leaks.

This article is reprinted from Oregon State University Extension Service Publication EC 1286, February 1990

INSIDE

Northern Building Science is published bimonthly by the Alaska Craftsman Home Program, Inc. (ACHP). ACHP is a non-profit corporation providing education and technical information on cold climate building construction to the shelter industry and all Alaskans.

Ginny Moore, Editor

Unsolicited contributions and manuscripts are welcome. We cannot be responsible for loss or damage. While every effort is made to provide accurate and complete information, we do not warrant or guarantee the accuracy and completeness of such information, nor can we endorse any particular product.
Address subscription requests, letters, manuscripts to
Editor, Northern Building Science
Energy Resource & Information Center
949 E. 36th, Suite 403
Anchorage, AK 99508
Phone 561-8966 or 800-478-4636

ACHP Director: Harvey Bowers
Telephone: 907/373-2247 or
800-478-ACHP

ACHP Board of Directors
Representing Alaska Homebuilders Association:
Tim Sullivan, Chairman, *Anchorage*
Larry Taylor, *Anchorage*
Bruce Denton, *Juneau*

Representing Banking Industry
Randy Boyd, *Anchorage*

Representing Energy Rated Homes of Alaska
Mary Webb, *Anchorage*

Representing AK Dept. Comm. & Regional Affairs
Steve Baden, *Anchorage*
Chuck Akers, *Anchorage*

Representing University of Alaska
Richard Seifert, *Fairbanks*

Representing Alaska Craftsman Home Program
Terry Duszynski, *Fairbanks*
John Sullivan, *Kodiak*

Representing Appraisers
Fred Ferrara, *Anchorage*

Representing Realtors
Robin Ward, *Anchorage*

furnaces and gas water heaters, for example, depend on the stack effect to remove the hot exhaust gases from combustion out of the house. In all but the newest units, house air is used for combustion, creating a negative pressure around the burner, further increasing the infiltration of cold air if the appliance is located in the basement or ground floor.

Mechanical devices, such as exhaust fans or clothes dryers, also increase air leakage in homes. Furnace blowers, although not exhausting to the outside, can affect air leakage in homes significantly. While the furnace blower is operating, the negative pressure typical around the furnace may temporarily increase the air infiltration in the basement, while the positive pressure created upstairs increase the rate of exfiltration in other parts of the house.

Some people try to solve the problem of cold floors by using ceiling fans to circulate hot air from the ceiling. Although these fans do help distribute heat, the amount of energy saved is minimal since the destratification mostly masks the continuing air leakage problem. Sealing hidden air leaks is the most effective way to solve warm ceiling-cold floor problems. In a well-sealed two-story house, temperature difference between floors should be less than 3°F.

Can My House Be Too AirTight?

You may worry that by air tightening your home you could trap moisture and other pollutants that previously were carried outside by the escaping air. Over the course of a year the rate of air leaks in a home varies considerably. Depending on the season, local weather conditions, use of exhaust fans, and heating system operation, the air leak rate of a home can vary by a factor of ten during a single day. During winter, when doors and windows are closed, the air exchange resulting from stack-driven air leaks probably exceeds the ventilation requirements of most homes. But in spring and fall, when houses are still closed and indoor/outdoor temperatures don't differ enough to create a strong stack effect, the indoor air quality in many homes, particularly those with fireplaces and woodstoves, may already be temporarily affected (Fig 2). In certain circumstances, the power of the interior stack effect can actually overpower the chimney draft and pull exhaust gases into the home. Occupants sometimes unwittingly contribute to the problem of chimney backdrafting by opening an upstair window to provide some additional fresh air, thus increasing the pull of the interior air leakage against the draft of the chimney.

Even professional weatherization contractors using blower doors rarely seal homes tighter than one-third air change per hour, a limit presently believed to provide adequate fresh air without a mechanical ventilation system for most homes. Using the air sealing techniques presented here it is highly unlikely that you could tighten your house up sufficiently to affect air quality unless the house already has serious pollution problems. For this reason it is essential to identify and correct any existing pollution and moisture problems before tightening your house.

Look for signs of indoor air pollution such as mold and mildew on walls, window frames, and ceilings caused by high winter humidity levels. Corrosion or rust around flue pipes above oil or gas furnaces and

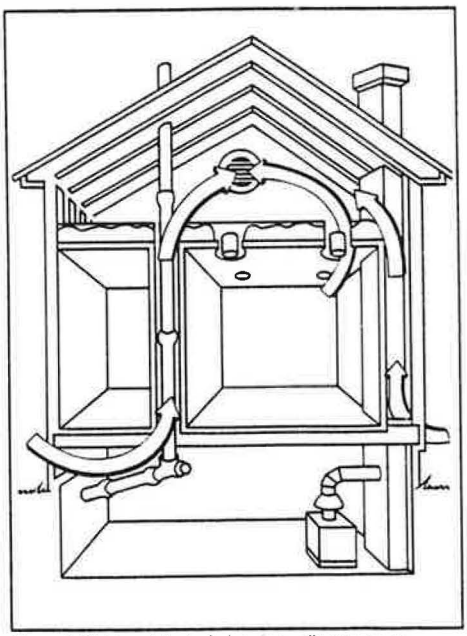

Figure 2. Hidden air leaks in interior walls can cause furnace gases to "backdraft" into the house.

water heaters indicates furnace backdrafting. You can verify radon levels using inexpensive testing kits available in department and building supply stores. Correct these problems before undertaking air tightening measures.

Other weatherization measures you may install can affect the overall air leakage rate of a house: cellulose insulation in walls typically reduces cold wind-driven drafts, and storm windows reduce air leakage around window openings. None of these, however, affect the hidden air leaks in a home.

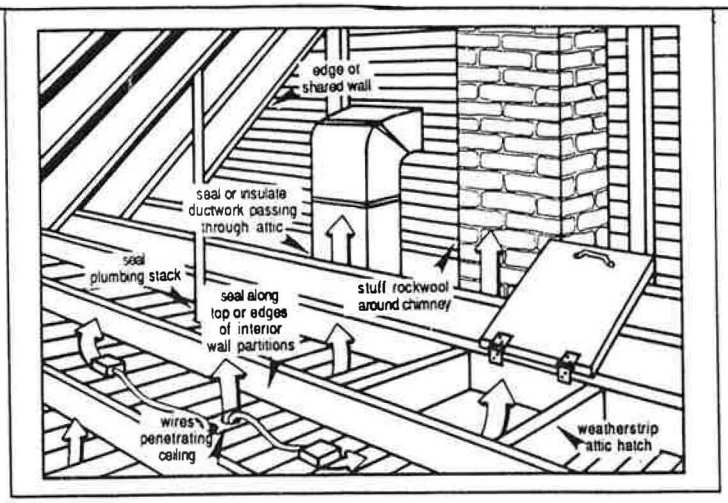

Figure 3. Important places to stop air leaks into attics.

Where To Find Air Leaks

The Wisconsin Energy Conservation Corporation's weatherization program developed a very effective air sealing priority list as part of the Energy Audit System. Techniques for safely sealing each area are detailed below.

1. Seal the big holes, especially the ones that are cheap to fix, such as replacing broken glass and caulking electrical and plumbing holes.

2. Seal leaks in areas of greatest pressure difference. Usually these are leaks into the attic, through the upper floor ceiling, basement, or foundation holes (Figure 3).

The most common locations include:
* **Attic bypasses**, including plumbing vent stacks and chimneys passing into the attic.
* **Attic access panels** or doors. Weatherstrip these and add a latch to hold them tightly closed.
* **Sillplate** (mudsill) and other foundation leaks, such as poorly fitting basement windows. The sillplate is on top of the foundation walls and what the floor joists rest on.
* **Open floor joist ends** in kneewall attics. (See detailed description below.)
* **All joints in forced air ductwork**, both heat supply and return air ducts.

Remember, the purpose is to close off the top and bottom of the hidden passageways through which warm air is escaping and cold air is entering. Since air leaks can easily move inside walls and find other ways of escaping, sealing these leaks from the inside surfaces of the home is most effective.

3. After the above areas are sealed, undertake the standard caulking and weatherstripping projects. The Wisconsin guidelines suggest the following jobs be addressed next:
* Weatherstrip exterior doors, if necessary. A door to an unheated garage or basement should be considered an exterior door.
* Weatherstrip windows, if necessary. Adjusting sash locks and stops is often more effective than installing weatherstripping in windows.
* Replace cracked glass.
* Other interior caulking locations may be located if you have access to a blower door.

Sealing Materials

To get started, first survey your home from the inside to find where the air leak pathways might be located. Check in the attic for plumbing pipes, interior partition in rooms below; in the basement for plumbing and ductwork leaks and around built-in cabinets and drop ceilings. Remember that the most effective way to stop this undesirable air movement is from inside the house. Then decide what sealing materials you'll need.

You'll probably need latex caulk, spray foam, high temperature duct tape and some plastic bags and fiberglass insulation for other holes. To seal around chimneys and metal flues use rockwool and special high temperature caulk. For the majority of your interior sealing use inexpensive latex or "acrylic latex" caulk which costs about $2 per tube and is quite long lasting. Use it for sealing narrow cracks and holes in the living areas of your house and any other holes smaller than about 3/8 inch. Caulk is simple to use, gives a finished look, sets up quickly for painting, and is easy to clean up. Begin caulking in out-of-the-way areas of your house while you learn to control the caulk gun to get an even "bead" of caulk.

For sealing cracks and holes up to about 1 inch wide in basements and around windows and door rough openings, some people use expanding urethane foam, sometimes called "spray foam" or "single component"urethane foam. It costs about $5 per can. Some foam will continue to come out the nozzle after you stop pressing the trigger, so begin in an area where some foam dripping won't matter. Keep a rag handy to catch drips. The foam takes from 6-12 hours to harden, depending on indoor humidity levels. After it is dry, you can trim the excess with a pocket knife. Wear old clothes and rubber gloves when working with spray foam as it is very difficult to clean up, even using paint thinner as a solvent. Tubular polyethylene backer rod or fiberglass stuffed into plastic vegetable bags from the supermarket are also effective for sealing larger openings. Other materials you may need include high-temperature foil duct tape for sealing forced-air heating ducts (available from heating contractors or wholesalers) and about 2 square feet of rock wool or class I fire-rated fiberglass insulation for stuffing tightly around chimney or woodstove flue pipes. If you have an attic that is converted into living space, see the section on kneewall attic spaces for special materials to seal the floor joist area, in the next issue.