Venting the Roof

With today's construction methods, the minimum code requirements may not be enough

by Kevin Ireton

On the subject of roof ventilation, the Canadians are fond of quoting Gus Handegord, one of their premiere building scientists. Handegord says, "If you go into an attic in the winter, find frost on the underside of the sheathing and there are no vents, you should put some in. But on the other hand, if you go into an attic in the winter, see frost on the the underside of sheathing and there are vents, close them up."

Although his advice sounds contradictory, Handegord simply recognizes that attic ventilation is a relative issue. How, where, when and even whether you should vent your roof depends on the type of construction, level of insulation, climate, site and probably a dozen other variables. The truth is, very little research has been done on roof ventilation, and the experts don't always agree on what's best.

In this article the term "roof ventilation" refers to a vented air space over the insulation in an attic or a cathedral ceiling. Roof ventilation should not be confused with house ventilation. In a tightly built house mechanical ventilation is needed to expel stale air and to bring in fresh air for breathing and combustion (for more on mechanical ventilation see *FHB* #34 pp. 30-34).

Codes and warranties—All the building codes require roof ventilation. Most of them enforce 1:150 and 1:300 ratios. According to these ratios, you need a *minimum* of 1 sq. ft. of net free vent area (NFVA) for every 150 sq. ft. of ceiling area below the roof. (The NFVA is the total area of the vent opening and takes into account the area blocked by any screening or louvers.) If you use a vapor barrier on the ceiling, however, or if you divide the ventilation evenly between high and low vents, then the minimum is 1 sq. ft. of NFVA for every 300 sq. ft. of ceiling. The vapor barrier reduces the amount of moist air infiltrating the attic, hence reducing the need for ventilation. Dividing the ventilation between high and low vents increases its efficiency, which also reduces the amount of ventilation needed.

Manufacturers of asphalt and fiberglass shingles also agree that ventilation is a good idea, at least for the longevity of their products. Ventilation under the roof deck (to reduce heat buildup) is a condition of shingle warranties. Some manufacturers (Georgia-Pacific, for instance) even go so far as to stipulate the 1:150 ratio.

A little history—Prior to the 1930s, people didn't vent their roofs. They didn't have to. Roofed with wooden shingles over open sheathing, and with little or no insulation in the attic, houses weren't tight enough to trap heat or moisture. But the next 60 years saw the advent of building papers, asphalt shingles, plywood, insulation and vapor barriers, which had the same effect as putting a lid on a pot of boiling potatoes. As a result, moisture—from breathing, cooking, bathing, plants—began to accumulate inside houses. Households weren't generating more moisture, but tighter houses were retaining more of it.

As a result of warm air leaking from the house into an unvented attic in Manitoba, Canada, severe frost accumulated on the underside of this roof sheathing. When the frost melted, it literally rained in the attic.

***The ice dam cometh.* As heat from the house leaks through the ceiling and up to the roof, it melts the bottom layer of snow. The water flows down to the cold eave, refreezes and forms a dam. Subsequent melting forces water and ice to back up under the shingles.**

By the 1940s problems with mold, mildew and peeling paint were common enough that Frank Rowley at the University of Minnesota was investigating the use of ventilation to remove moisture from attics. It was his research that eventually led to the adoption by the FHA and subsequently by the building codes of the 1:150 and 1:300 ratios. These were the levels of roof ventilation deemed necessary for the leaky, poorly insulated houses typical of the 1940s. And these ratios served fairly well for the next 30 years.

Since the energy crisis in the 1970s, however, builders and remodelers have been tightening walls and ceilings and adding still more insulation. This means that attics are colder and that any house air escaping into them is likely to have a much higher moisture content than ever before—the ideal conditions for condensation. Curiously, the building codes have not been revised to reflect these changes.

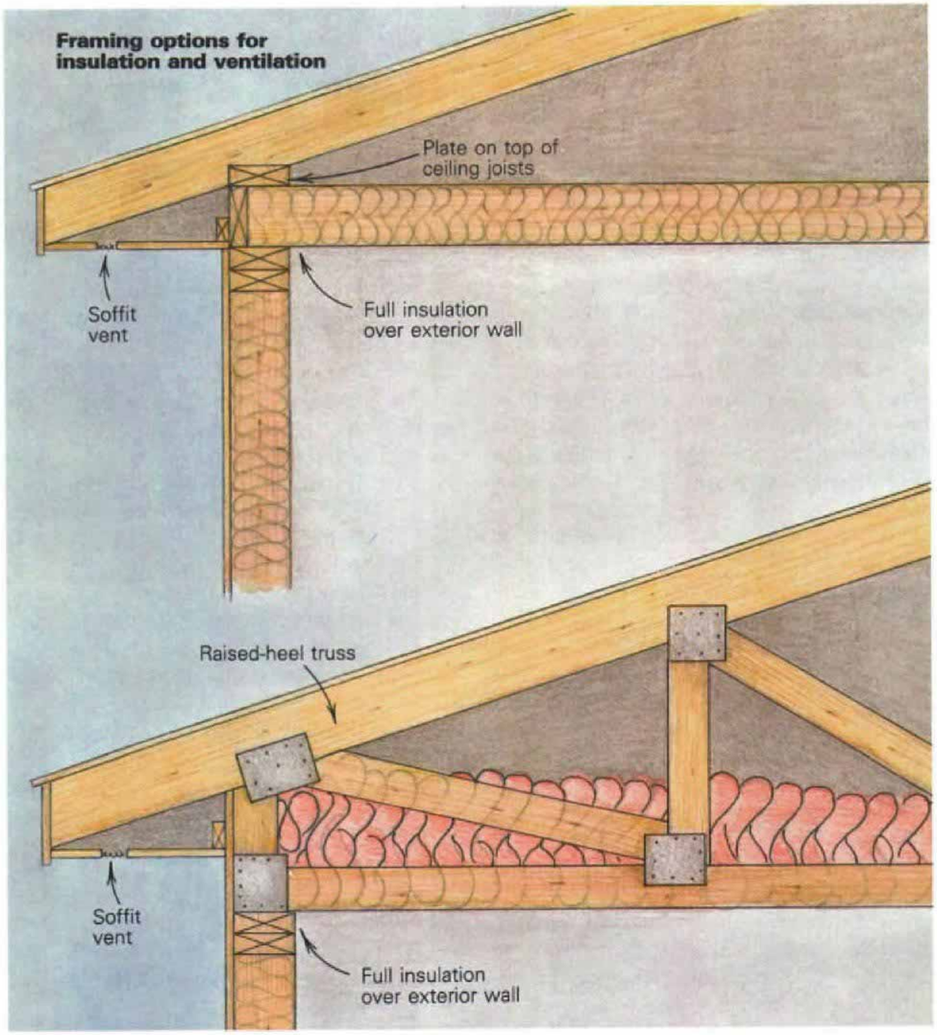
Venting for moisture reduction—Moisture buildup in a roof can lead to peeling paint, wet insulation, the growth of mold and mildew, and ultimately to failure of the roof structure. Architects, builders, building scientists and vent manufacturers may argue about ventilation, but they all agree that keeping moisture out of the roof in the first place is the best way to eliminate problems. And by now most of them agree that air-transported moisture causes more problems in roofs than does moisture from any other source (such as vapor diffusion).

If you have a tight house with lots of insulation, you must seal up air leaks from the house into the roof. This doesn't mean you have to use a polyethylene vapor barrier. Carefully installed, drywall does just fine at stopping air leaks (for more on this see *FHB* #37, pp. 62-65). But chimneys, partition walls, holes drilled for electrical and plumbing runs, fiberglass tubs with integral surrounds, recessed can lights, electrical boxes and attic hatches all allow moist house air to flow into the attic. And holes cut for plumbing vents are probably the worst culprits. They should be sealed with caulking and a gasket made from a piece of rubber (EPDM) membrane.

Top photo by Harold Orr, courtesy of the Institute for Research Construction, National Research Council of Canada

If warm, moist, house air does leak into the attic, ventilation air will carry it out before it has a chance to condense on the cold underside of the sheathing (top photo, facing page). But as air gets colder, its ability to absorb moisture is reduced. So as you increase the insulation levels in the ceiling, you make the attic air colder and decrease its ability to cany off moisture.

What should you do? Joe Lstiburek, a Canadian building engineer, says that if you live in a superinsulated house (with ceiling insulation levels of R-45 or more) in a very cold climate, you should close your roof vents during the winter. Clarke Wolfert, a professional engineer and technical director for Air Vent, Inc., simply says you need to increase the ventilation rate in the attic and move more air through it.



Venting to prevent ice dams–Ice dams form when snow on the roof melts, flows down and freezes again as it hits the relatively colder eaves. The accumulation of ice actually forms a dam, and subsequent melting forces water and ice underneath the shingles behind the ice dam (bottom photo, facing page). If a house is well insulated, losing little or no heat through the ceiling, then the snow on the roof won't melt.. .at least not right away.

Problems arise as snow accumulates on a roof; if it's relatively dry, snow is a good insulator–about R-1 per in. Accumulating snow insulates the roof surface, which means that even the slightest heat loss (i.e., thermal conduction) can raise the temperature of the roof surface above freezing. This melts the snow sitting directly on the roof, which then flows to the eaves where it freezes. Proper ventilation creates a thermal break and circulates cold air under the roof, keeping the surface of the roof colder and preventing the snow from melting.

Venting to reduce heat buildup–The third basic reason for venting roofs is to reduce the buildup of heat in hot weather. Especially when used in conjunction with a radiant-barrier system in southern climates, roof ventilation significantly lowers the cooling bill and raises the comfort level of houses. But studies done at the Florida Solar Energy Center (FSEC, 300 State Rd. 401, Cape Canaveral, Fla. 32920) have shown that shingle and sheathing temperatures are far more dependent on shingle color than they are on ventilation. So if you're really worried about heat buildup, use light-colored shingles in addition to ventilation.

Can moisture, in the form of hot, humid air, actually enter the attic through the vents? If the house is air-conditioned, will moisture then condense on the back of the ceiling drywall? According to Philip Fairey, principal research scientist at the FSEC, the answer is yes, if the thermostat is set low enough. With the air-conditioning set at 77° or above, however, the chances of condensation problems are negligible.

Lstiburek says, just in case, use 1-in. thick vapor-impermeable insulating sheathing (foil-faced rigid foam) behind the ceiling drywall, if you live in a cooling climate. Such sheathing would stay relatively warm on the attic side and reduce the chances of condensation.

Warm roofs, no vents–Bob Corbett, the senior technical specialist with the National Center for Appropriate Technology (P. O. Box 3838, Butte, Mt. 59702-3838) says that seven years ago he built a house in Montana with a flat, unvented roof and has had no moisture problems. John Abrams, a designer and builder on Martha's Vineyard has been building houses with unvented cathedral ceilings for seven years without any problem. Gary Nelson, an energy expert in Minneapolis, says that he has solved ice-dam problems in houses with cathedral ceilings by using a blower door and an infrared camera to find air leakage paths, then packing them full of cellulose.

In each case these folks are building a "warm roof"–one that has no vent space, as opposed to a "cold roof," which has cold air flowing through it. And in northern Canada, where wind-driven snow can infiltrate the best vents with frightening proficiency, warm roofs are becoming the norm, according to Rob Dumont, an engineer and research specialist with the National Research Council of Canada. The success of a warm roof depends on a nearly perfect air/vapor barrier. But according to Ned Nisson in *Residential Building Design & Construction Workbook* (see suggested reading, p. 80), warm roofs are not a good idea where roof snow accumulations of 8 in. or more are common for extended periods of time because of potential ice-dam problems.

Continuous soffit and ridge vents–Despite some of the potential problems with roof ventilation, all engineers and scientists consulted for this article answered "yes" when asked directly, "Should I vent the roof?" And all agreed that the most efficient way to do it is with continuous soffit and continuous ridge vents.

Roof ventilation should be balanced between intake vents low in the roof and exhaust vents high in the roof. As long as there are no obstructions, air will move in a relatively straight line between the intake vents and the exhaust vents. Continuous soffit and ridge venting is the only system that directs this air uniformly along the underside of the entire roof. And this is where you want the ventilation, whether it's removing moisture, preventing ice dams or cooling the roof. Other types of exhaust vents, such as gable vents, roof louvers, and turbine vents, can leave portions of the roof unvented. This is true even when

Drawings: Michael Mandarano

they're used in conjunction with soffit vents (which they should always be).

The 1:150 and 1:300 ratios are minimum requirements, developed for "leaky" houses. In general, continuous soffit and ridge vents provide three times the amount of NFVA required by the 1:300 ratio. Ideally, 50% of NFVA should be in the ridge, and 25% should be in the soffit on each side of the house.

Soffits are the best place for the intake vents because they're protected from the weather. And for maximum efficiency soffit vents should be as close to the fascia board as possible.

The most common complaint about ridge vents, especially among architects, is that they're ugly. But in a 32-ft. long house, you would need 11 roof louvers or 5 turbine vents to achieve the same NFVA as a continuous ridge vent.

Many architects and builders prefer the look of gable-end vents, and in some climates and situations they work fine. But gable vents are dependent on wind direction and speed to work. And when they work, gable vents move air down the center of the roof under the ridge, leaving large areas of the roof unvented. One thing you should never do is combine gable and ridge vents. This would result in short circuiting, where the ridge vent draws intake air from the gable vent rather than from the soffit vent.

Although there may be rare situations—shallow-pitched hip roofs, perhaps—where powered ventilation (attic and roof fans) is called for, powered ventilation generally costs more than it's worth. For one thing, power venting can depressurize the attic enough to suck moist air out of the house and into the attic, causing problems rather than solving them. Tests conducted by the Florida Solar Energy Center found that the additional attic air changes resulting from fan-forced ventilation did not cool the attic significantly enough to offset the cost of running the fan.

The most common way to vent a cathedral ceiling is with polystyrene baffles stapled against the roof sheathing to prevent the fiberglass batts from blocking the air path in the rafter bay.

Tricks and tricky spots—Insulating over exterior walls while maintaining an air space for ventilation is a common problem. Two of the best solutions are either to use a raised-heel truss (drawing preceding page), or if you're framing with rafters, to run a plate across the tops of the ceiling joists and let the bird's mouth sit on it. Cardboard and polystyrene baffles are available for containing insulation over exterior walls and keeping it from blocking the soffit vents.

One of the easiest ways to encourage ventilation at the ridge is to drop the ridge board ¾ in. below the tops of the rafters (check this detail with your local building inspector first). This same idea works to move air over a hip rafter. Drop the hip rafter below the jacks, and let the sheathing bear on the jacks.

Dormers, especially if they have a cathedral ceiling in them, are tough to vent. If you can't use conventional methods, your best bet is to take special care with the air/vapor barrier around the dormer ceiling.

Venting around skylights in cathedral ceilings has always been a problem because the skylight blocks the air passage in one or more rafter bays. You can cut notches or drill holes in the cripple rafters above and below the skylight to provide an air channel into adjoining rafter bays. Some people will tell you this is a waste of time because ventilation air won't move laterally, at least not very well. Yet the same people agree that it doesn't hurt, and offer no alternatives.

The lack of ventilation around skylights makes them a common cause of ice dams. The folks who make Velux skylights (Velux-America Inc., P. O. Box 3268, Greenwood, S. C. 29648) recommend using an ice shield membrane on the roof deck 2 ft. to 3 ft. around the skylight and up the curb, under the flashing. This won't prevent ice dams, but it may keep the roof from leaking as a result of them.

One brand of skylight, CeeFlow Skylights (P. O. Box 98, Harbor Springs, Mich. 49740), actually boasts a vent space between its double-pane window and its acrylic lens. This allows an unbroken flow of air through the rafter bays that the skylight intersects. This may not eliminate ice dams, either, but sure seems a step in the right direction (for more on CeeFlow, see *FHB* #48 p. 90).

Kitchen and bathroom vent fans are a common source of attic moisture. They should *never* be vented into the attic or out the soffit. In fact, they should be located in walls rather than in ceilings and vented down and out through the floor. If the vent fan ducts do run through the attic or ceiling, insulate the ducts to keep condensation from accumulating inside them so that no moist air leaks into the cold roof.

Recessed lights are another problem area because most require that insulation be 3-in. away. This means that heat and air leak around them into the attic. If you can't avoid putting them in the ceiling, at least use the recessed can lights that can be insulated. They're called ICT lights and are made by various manufacturers, including Lightolier (100 Lighting Way, Secaucus, N. J. 07096) and Thomas Industries, Inc. (Residential Lighting Division, 950 Breckinridge Lane, Suite G50, Louisville, Ky. 40207).

Cathedral ceilings—The most common way to vent a cathedral ceiling built with dimension lumber is to use continuous soffit and continuous ridge vents and then maintain a 1-in. to 2-in. air space above the insulation in the rafter bays. The best way to maintain that air space is with polystyrene baffles stapled to the underside of the sheathing (photo left). These baffles, manufacturerd by various companies, prevent the fiberglass insulation from blocking the airspace. By framing the roof with scissors trusses, laminated wood I-beams or with parallel-chord trusses rather than solid lumber, you can obtain more room for insulation and ventilation.

Many timber-frame houses these days have cathedral ceilings built with stress-skin panels. To comply with the shingle warranty, timber-framer Tedd Benson nails furring strips horizontally and a layer of plywood on top of the panels as a nail base for asphalt shingles. Then he vents the space by dropping the crown mold along the rakes slightly and covering the space with screening.

Although Benson doesn't use them, another approach would be to cover the roof with panels that have air spaces integrated into their design. Both Branch River Foam Plastics, Inc. (15 Thurbers Blvd., Smithfield, R. I. 02917) and Cornell Corp. (P. O. Box 338, Cornell, Wisc. 54732) make such panels.

Manufactured vents—Many companies make soffit and ridge vents, and whose products you use will likely depend more on what's available from your favorite supplier than on which product performs best. Air Vent, Inc. (4801 N. Prospect Rd., Peoria Heights, Il. 61614) offers a number of products that represent what's available (photos facing page).

Air Vent's basic ridge vent is made of aluminum (.019 in. thick) and has an integral baffle, which they claim reduces rain and snow infiltration and enhances ventilation by deflecting wind over the vent and creating an area of negative pressure (the Venturi effect) that pumps air out of the attic. Air Vent also sells the same vent with a fiberglass filter in it (Ridge Filtervent) that's supposed to reduce further the chance of rain or snow infilatration. According to Air Vent, the filter also deters insects, particularly cockroaches (a problem in warm climates), from entering the attic.

Air Vent makes a product called Flash Filtervent that allows ventilation where a shed roof meets a vertical wall, and one called Utility Vent that is simply an integral baffle and louver you can use to make your own ridge vent. Air Vent sells a shingle-over ridge vent (Shinglevent), also with an integral baffle, made of high-density polyethylene. A shingle-over

Air Vent's Ridge Filter Shinglevent

Air Vent's Ridge Filtervent

Cor-A-Vent's Ridge Vent

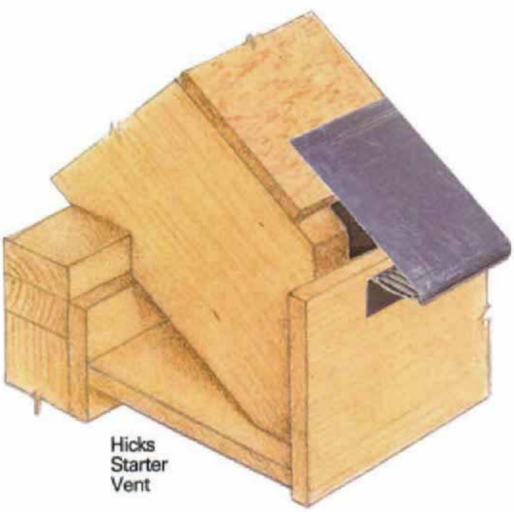
Air Vent's Utility Vent

Mid-America's RidgeMaster

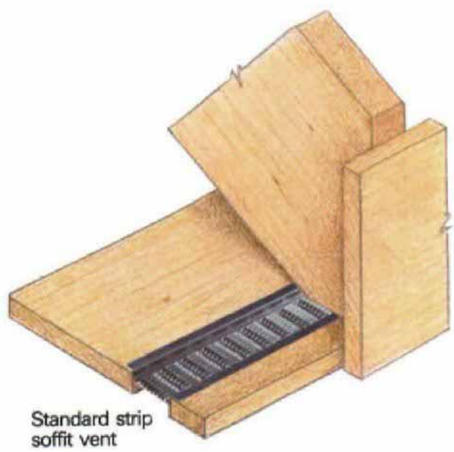
Air Vent's Flash Filtervent

Greenstreak's Top Cat

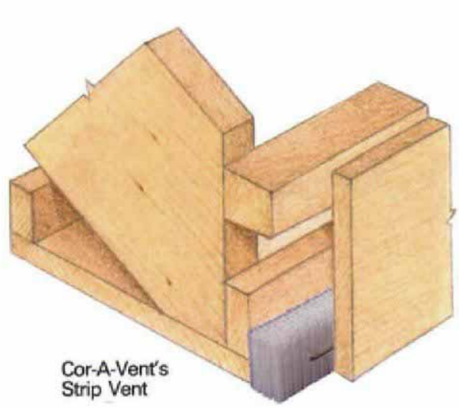
Manufactured vents: *The most efficient way of venting a roof is with continuous ridge and continuous soffit vents. And while you can make your own vents, there are a wide variety of manufactured products designed to do the job. Pictured here are some of the more common vents, as well as some of the more interesting.*



Hicks Starter Vent



Standard strip soffit vent



Cor-A-Vent's Strip Vent

vent is a ridge vent over which you can nail ridge caps to make the vent less obtrusive.

The original shingle-over vent was Cor-A-Vent (Cor-A-Vent, Inc., 16250 Petro Drive, Mishawaka, Ind. 46544). It was invented in the early 1970s by Gary Sells, a builder in northern Indiana. The prototype was made with layers of corrugated cardboard, coated with epoxy, and according to Sells, is still in place today. Sells had to wait for plastic technology to catch up with him before he could go into production. Now Cor-A-Vent is made of six layers of corrugated plastic, stapled together and beveled (photo previous page). By cutting Cor-A-Vent in half lengthwise, you can use it to vent shed roofs and clerestories. Cor-A-Vent also makes a 1½-in. by 1-in. corrugated plastic soffit vent, available in white or black.

At the same time that Sells was developing his product, another builder, Robert Hicks, was designing a combination drip edge and vent (photo previous page). Since then several other companies have come out with similar products, but Hicks Starter Vent (124 Main St., Westford, Mass. 01886) was the first. Drip-edge vent is installed the same way as standard drip edge, but extends beyond the roof sheathing to create a sheltered overhang for a row of louvers. Besides their use on houses with no soffits, drip-edge vents are often the easiest way to retrofit intake vents on a house.

Over the past few years many new ridge vents have appeared on the market, including RidgeMaster (Mid-America Building Products Corp., 9246 Hubbell Ave., Detroit, Mich. 48228), a polypropylene vent with a system of internal baffles and a layer of filter material woven through them (photo previous page). Another polypropylene vent, Top Cat (Greenstreak, 3400 Tree Court Industrial Blvd., St. Louis, Mo. 63122) has vent openings in the top rather than along the sides (photo previous page). Unfortunately, there is no trade association of passive-vent manufacturers, so it's tough to know how many others might be out there.

The permanent ridge vent

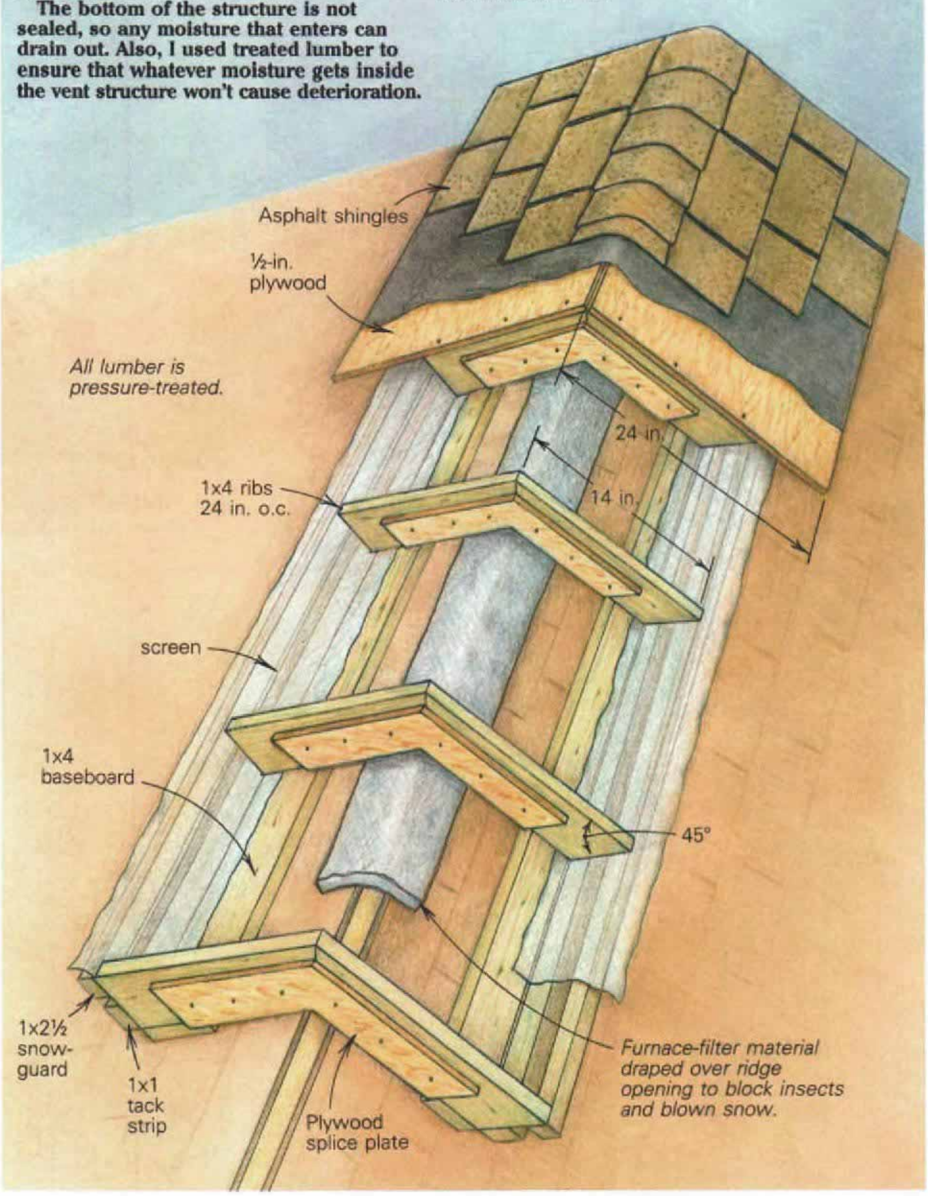
During the construction of our cathedral-ceiling family room, I installed a prefabricated aluminum ridge vent. Three years later it started leaking, and rather than trying to solve the leaks, I decided to install a permanent, maintenance-free vent structure.

I used the same construction as the basic roof—plywood sheathing covered with asphalt shingles. It was easy to build, blended with the existing roof and the only maintenance will be the replacement of shingles every 20 years, along with the those on the rest of the house.

The bottom of the structure is not sealed, so any moisture that enters can drain out. Also, I used treated lumber to ensure that whatever moisture gets inside the vent structure won't cause deterioration.

I needed an overall length of 32 ft., so I opted for two 6-ft. and two 10-ft. sections. This way the 8-ft. lengths of plywood overlap the joints between the frame sections and tie the whole structure together. I assembled each section in two halves, working on the floor of my garage. Once the frame was in place on the ridge, the sheathing pieces were glued and screwed to the ribs to resist uplift forces during high winds.

—R. W. Missell, an electrical engineer in Annandale, Va.



Site-built vents—A lot of builders make their own soffit and ridge vents because they don't like the look of manufactured vents. The drawing at the left shows one design for building a ridge vent (other designs were featured in *FHB* #21 pp. 51-53 and *FHB* #52 p. 50). To create their own soffit vents, builders usually cut a slot in the soffit and staple screening to the backside. It is also possible to cut decorative shapes in the soffit. Some builders use a 2-piece fascia board with an air space between, covered with screening. It's not advisable to use insect screen (1/16-in. mesh) to make vents, though. Insect screen is 50% closed, meaning it reduces by 50% the NFVA of whatever opening it covers. Also, insect screen can easily become clogged with dirt or paint. Use 1/8-in. mesh or larger. □

Kevin Ireton is managing editor of Fine Homebuilding.

Suggested reading

Here are some of the publications I found helpful while working on this article. *—K. I.*

- *Principles of Attic Ventilation,* available from Air Vent, Inc., 4801 N. Prospect Rd., Peoria Heights, Il. 61614. $3, 30 pp. *Probably the best single source of information on the mechanics of attic ventilation.*
- *Roof-Snow Behavior and Ice-Dam Prevention in Residential Housing,* by Howard L. Grange and Lewis T. Hendricks, available free from Air Vent. *A thorough treatment of ice dams, their causes and solutions.*
- *Residential Building Design & Construction Workbook,* by J. D. Ned Nisson, Cutter Information Corp., 37 Broadway, Arlington, Mass. 02174, 1988. $85, softcover, 347 pp. *Expensive, but worth the cost. An in-depth explanation of superinsulation theories and techniques, including information about airtight construction and roof ventilation.*