

All About Rain Gutters

Whether aluminum, copper, steel or plastic, gutters need good design and proper installation to put roof runoff where it belongs

BY ANDY ENGEL

You've probably cursed your gutters more than blessed them. Purposeful yet troublesome, gutters are conspicuous as architectural afterthoughts on the otherwise carefully designed facades of many houses. Gutters clog with composting leaves, and in my neighborhood, they often sprout thickets of maple seedlings. In the north country, gutters that are half-torn from the house by sliding snow predict spring's arrival more accurately than does any groundhog.

Despite their shortcomings, gutters are essential to the longevity of most homes. Without gutters and downspouts leading rainwater away from the house, foundations become feedlots for mold that can sicken your family and rot your house. Wet foundations lead to peel-

ing paint and even to damp attics (see "Fixes for Damp, Moldy Houses," pp. 74-79).

Unless the soil that is surrounding your house is free-draining gravel that never saturates or unless you live where rain is only a Christmas-tree decoration, your house needs gutters. Here's how to make the best of them.

There's more to choose from than seamless aluminum

One of the first choices you'll have to make is what material and profile your gutters should be. The most common materials are aluminum, copper, galvanized steel and plastic. The Architectural Sheet Metal Manual (Sheet Metal and Air Conditioning Contractors Na-

tional Association Inc./SMACNA; 703-803-2980) lists over a dozen standard profiles. (At \$176, this book is pricey, but it shows every flashing and sheet-metal detail imaginable.)

The most common gutter in use nationally is 5-in. aluminum K-style (photo left, p. 98). K-style gutters are called by that name simply because the profile's place in SMACNA's alphabetical hierarchy is the eleventh letter of our alphabet. The seamless-gutter contractors that I know produce miles of this rectangular-back, ogee-front gutter every year.

Seamless gutters are the least likely to leak. Specialized truck-mounted or trailer-mounted forming machines pull flat metal stock from a coil and shape gutters of the desired profile on site. One-piece lengths as long as the stock on the coil are possible, but thermal expansion and contraction limit the practical length to about 50 ft. These forming machines are costly, and contractors are likely to be able to produce only 5-in. and maybe 6-in. K-style.

Of course, lumberyards and specialty wholesalers sell these and other profiles already formed, but their lengths are usually limited to 10-ft. or 20-ft. sections that must be joined on site.

The problem with joining gutter sections is that joints are leak-prone. On metals that can be soldered, copper or galvanized steel, the sections must overlap by 1 in. and be riveted on 2-in. centers before soldering. Aluminum and painted steel can't be soldered. Their 1-in. lap must be sealed with paint-compatible gutter sealant or high-grade silicone caulk and riveted on 1-in. centers.

Custom gutters can also be bent on site with a sheet-metal brake, but when they're made that way, the section lengths are limited by the width of the brake, typically 10 ft. or less. If you're custom-bending gutters, the more longitudinal breaks you add to the profile, the stiffer the gutter will be. Make sure the front of the gutter is at least 1 in. lower than the back. Then, if the gutter fills up, it will overflow away from the house.

Half-round gutters drain better

Joining issues aside, profile choice is largely a matter of taste. Half-round gutters, for example, seem to go with several turn-of-the-century architectural styles. Square or angular gutters can work well on contemporary houses. A crown molding run below K-style gutters blends them into a fancy colonial cornice.

Half-round gutters may drain more completely than flat-bottom gutters. This fact makes sense when you think about how large an area exists at each gutter type's bottom, where water can linger. Why should you care about a little stagnant water in your gutters? In a word, mosquitoes. The solution is simple, though. Keep flat-bottom gutters free-flowing by substantially pitching them and cleaning them scrupulously.

Extending the roof's drip edge into the gutter is a good practice. It ensures runoff that may be drawn along the shingle's bottom by capillary action won't drip between the house and the gutter.

The drip edge stocked by my local lumberyard extends only about 1 in. below the roof, not far enough to reach into a more than minimally pitched gutter. Simply lapping a piece of flashing over the back of the gutter and under the drip edge makes up for this shortcoming. Gutters that have a straight back, such as K-style, lend themselves to this detailing. The brackets for half-round gutters usually push them far enough off the fascia to make running the drip edge into the gutter problematic.

K-style gutter is sometimes available with an integral flange at its back. The flange slides under the roofing material, much as the flashing detail I described for drip edge and gutter. Gutters of this design, though, must be installed parallel with the roof edge—that is, level,

SIZING GUTTER SYSTEMS

Gutter-system design takes into account likely rainfall intensity, roof size, gutter volume, and downspout size and frequency.

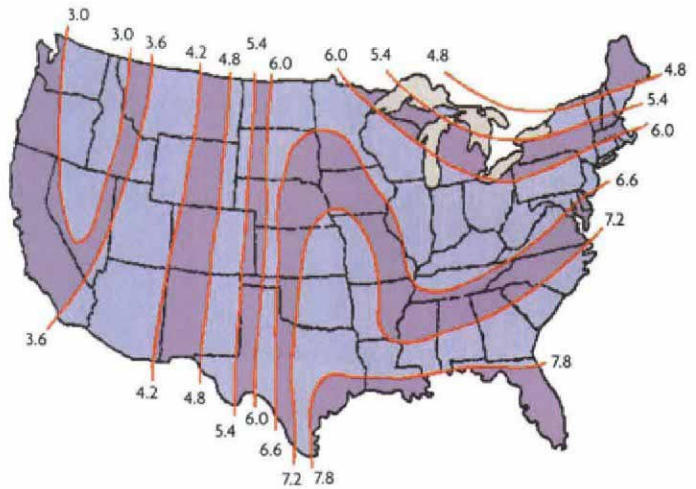
1. Calculate your roof's watershed area

A roof's watershed area isn't obvious. Maximum rainfall is likely wind driven, so steep roofs may collect more water than flat roofs. To figure a roof's watershed area, multiply its surface area by the appropriate factor from the table (right).

Roof pitch	Factor
12-in-12	1.3
9-in-12 to 11-in-12	1.2
6-in-12 to 8-in-12	1.1
4-in-12 to 5-in-12	1.05
Flat to 3-in-12	1

2. Find the maximum likely rainfall intensity

Residential gutters are often planned to handle the most intense five-minute burst of rain, measured in inches per hour, that's likely to occur in a ten-year period. Find yours from the map.



3. Determine the gutter needed to drain your watershed

Divide your favored gutter's 1-in.-per-hour watershed (table below) by the five-minute rainfall intensity (from 2, above). This determines the maximum watershed level gutters can serve between downspouts. Pitch your gutters by 1/8 in. per ft., and you can multiply the watershed by 1.4.

Each square inch of downspout cross section can drain 100 sq. ft. of watershed. So a 2-in. by 3-in. spout drains up to 600 sq. ft., and a 3-in. by 4-in. spout drains 1,200 sq. ft.

Going from one downspout to two doubles the watershed that a section of gutter can drain.

Watershed gutters drain at 1 in. rain per hr.		
	5-in. half-round	2500 sq. ft.
	6-in. half-round	3840 sq. ft.
	5-in. K-style	5520 sq. ft.
	6-in. K-style	7960 sq. ft.

Sample house

An 8-in-12 pitch shed roof in Washington D. C. is 40 ft. wide, and its rafter length is 20 ft. The roof's area is 800 sq. ft. The pitch factor for an 8-in-12 pitch roof is 1.1; when multiplied by 800 sq. ft., that gives a watershed of 880 sq. ft. The theoretical 5,520-sq. ft. watershed drained by a 5-in. K-style gutter, divided by Washington's 6.6-in.-per-hr. rainfall intensity, shows a maximum watershed of 836 sq. ft. Close, but to be safe, the builder should either pitch the gutter, use a larger gutter or add another downspout

ALUMINUM GUTTERS ARE THE MOST POPULAR

The K-style is frequently seamless, formed on site with a mobile machine. Installed for around \$3 per ft., these gutters are the standard. They're also available in 10-ft. or 20-ft. lengths, K-style or half-round, and they can be riveted together and sealed with silicone caulk.

Aluminum-gutter stock comes in several weights, the most common being 0.028 in. and 0.032 in. It usually doesn't cost much more to upgrade to the heavier 0.032 in., and the gutter will be harder to dent and will hold up better to heavy snow and ice.

Aluminum gutter stock comes prepainted, most commonly in white. Check with your supplier for other colors. Aluminum gutters last. My parents' gutters are 30 years old, dented and dull-colored, but water still flows through them as if they were new. Aluminum can be repainted; however, replacement them might not cost much more.



LONG-LASTING COPPER IS PRICEY

A commodity metal, copper sells by the pound, and its price fluctuates with the futures market. As of this writing, 5-in., 16-oz. half-round gutters cost \$4.20 per ft. locally. Copper's thickness is designated by weight. Sixteen-ounce sheet copper, standard for gutters, weighs 16 oz. per sq. ft.

Copper makes durable but easily dented gutters. Examples have lasted more than 50 years in corrosive seacoast environments. Copper's new-penny luster develops a green patina within a few years, and water dripping from copper can stain lower surfaces green. Runoff from cedar-shingle roofs is said to corrode copper fairly quickly.

Copper gutter can be formed seamlessly with the same equipment used to form aluminum gutters. It's also available in 10-ft. and 20-ft. lengths preformed as half-round and K-style. Being very malleable, copper lends itself to custom shapes and linings for concealed gutters.



unless you've had the forethought to custom-cut the rafters so that the roof pitches sideways.

An expansion joint keeps gutters from wrinkling

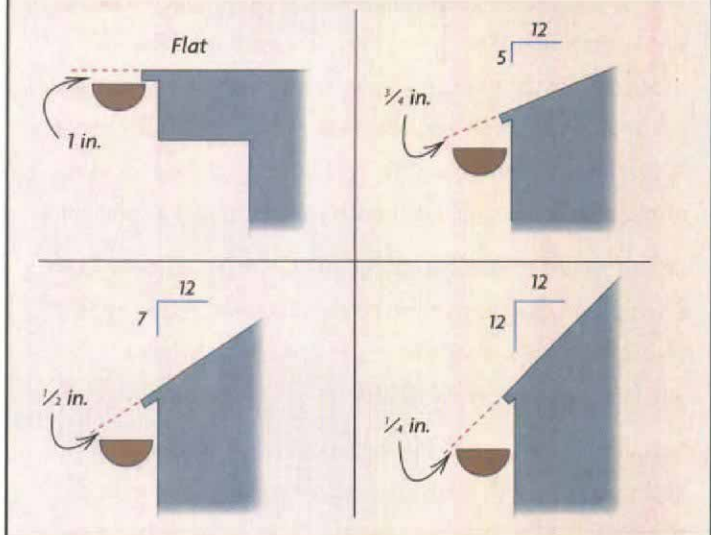
Gutters installed in extremely hot or cold weather, and those longer than 50 ft., may require some provision for expansion or contraction (photo p. 101). A 50-ft. aluminum gutter installed on a 0°F winter day will grow $\frac{3}{4}$ in. in length on a 100°F summer day. A long gutter

rigidly anchored on both ends, such as one that rounds two corners, is subject to expansion and contraction woes. Temperature-induced expansion or contraction can cause the gutter to wrinkle, or stress the seams, possibly to the point where the seal breaks and leaks begin.

The solution to this problem is an expansion joint in the run. Although an expansion joint sounds complicated, it's not. The gutter is divided in two, and both are ends capped. The ends are separated by the expected maximum expansion, based on the length of the gutter

Keeping gutters safe from snow

Drop gutters below the roof slope to keep snow slides from tearing them off. The safe distance from the front of the gutter to the line of the roof slope decreases as the roof pitch increases.



and the temperature when it's installed. An expansion joint dams the gutter, so a downspout is needed for each section.

Narrow downspouts clog more than wide downspouts

A few installation details can ease cleaning and minimize clogs. The simplest trick is to install wider gutters. It's easier to fit your hand inside a wide gutter than a narrow gutter. Also, wide gutters can handle more runoff and require more leaves to clog.

Downspout clogs can start when debris catches on the screws that hold spouts together. Blind rivets protrude less into the flow and are less likely to catch twigs and leaves. But if a clog develops, you have to drill out the rivet to disassemble the downspout for cleaning.

The best solution is probably to rivet the elbows to the downspout, and then to screw the assembly to the gutter so that it can be removed for cleaning. Use the shortest screws that will hold. Be sure to use screws or rivets made of the same material as the gutter. Otherwise, the fastener or the gutter will likely corrode.

Wider downspouts are less likely to clog, and they handle intense rainfall better than smaller spouts. Going from 2-in. by 3-in. downspouts to 3-in. by 4-in. spouts doubles the flow potential, for very few dollars. Because elbows slow water, minimize turns and maximize vertical runs of downspout. If possible, install at least a short vertical section above any elbows so that the runoff enters the turns at a good clip. Fast-moving water can often clear small clogs.

Double the usual number of hangers where ice forms

In northern climates, ice often clogs gutters and downspouts. Iced gutters can contribute to ice dams or simply peel off the house from the weight of the ice. A few years ago, snow slides left my gutters a twisted pile of aluminum in the side yard. Here are a few techniques that can ratchet the odds in your favor.

Particularly on the north side of the house, slope the gutters as much as possible to give snowmelt its best chance to drain. Sloped gutters drain faster than level gutters, but long runs may look bad. Adding even a 1-in. drop on a long gutter will help. Install downspouts where they get at least a little afternoon sun that might melt accumulated ice. On the north side of a house, that may mean ex-

MOST COMMON GUTTER HANGERS



1. Strap nails to the roof. Supplied in a gawky one-piece configuration that is site-bent around the gutter, these hangers are handy when no fascia exists.



1. Hidden hangers are an installer's favorite. The finished gutter looks sleek, and because the hangers clip to the gutter on the ground, installation is a breeze.

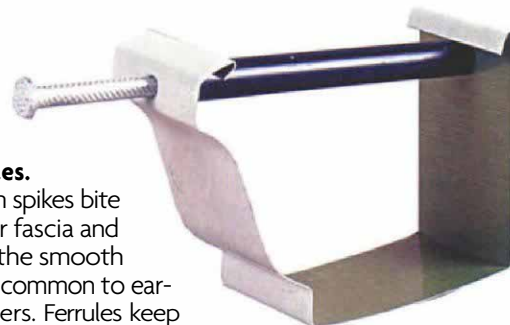
3. Snap-lock hangers help to keep the gutter from twisting.

Installation takes more trips up the ladder than with the other hangers because the brackets are nailed to the house before the gutter is placed.



4. These devices are not your father's spikes and ferrules.

Ribbed-aluminum spikes bite into the rafters or fascia and don't rust, unlike the smooth galvanized spikes common to early aluminum gutters. Ferrules keep spikes from crushing the gutter.



STEEL GUTTERS ARE HARD TO DENT NO CORROSION WITH PLASTIC GUTTERS

I worked on a 75-year-old house whose galvanized gutters leaked only at the lower-downspout elbows. There, swiftly moving water had worn away the protective zinc, and rust holes developed. The outside of these gutters hid under a paint layer thick as a tortilla chip, but even the unpainted gutter bottom had only begun to rust.

Exposed steel rusts. Steel can be galvanized with zinc; or it can be protected with Galvalume, a proprietary coating of zinc and aluminum, and with terne, a tin and lead alloy. Galvanized is the cheapest, about 70¢ per ft.

Steel gutters are available painted with the same slick, durable finishes found on commercial roofs. Steel is strong, and gutters made of it stand up well to the weight of ice and snow. Although K-style and half-round profiles are common, others are used on commercial projects and can be adapted to residential use.



tending the gutter just beyond the end of the wall so that the downspout can drop down the western side of the corner.

Half-round gutters suffer less ice damage than those with rectangular sections because their shape tends to guide ice upward as it expands. Smooth-side downspouts that clog with ice are more likely to burst than those made of corrugated material. Corrugation has some ability to stretch. To combat the weight of accumulated ice and snow, the gutter must be supported properly. Where winters can be intense,

space spikes or brackets every 1 ft. 6 in., or twice as frequently as normal. Another snow-country precaution: Install gutters so that the front lip is below the line of the roof slope (drawing p. 99).

Runoff from one roof to another can damage shingles

Upper roofs that drain onto lower roofs, such as on a porch that covers the front of a two-story house, may tempt you to decide against putting a gutter on the higher roof. Runoff from the upper roof will

Accommodating expansion

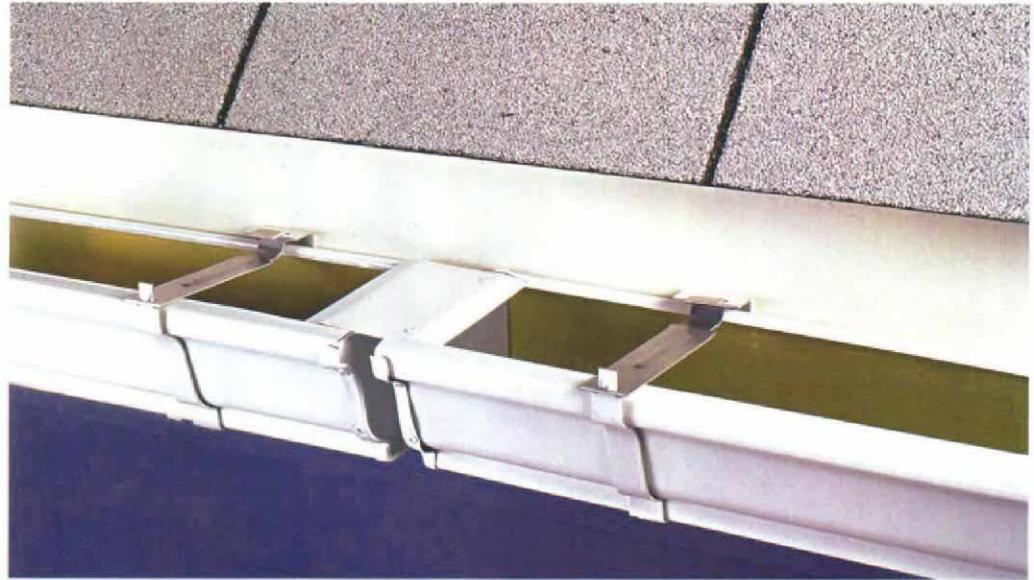
Steel: 0.0000067 in.

Copper: 0.0000094 in.

Aluminum: 0.0000129 in.

These numbers, coefficients of expansion, describe how much 1 in. of these materials expands or contracts with each degree of temperature change. For example, a 50-ft steel gutter installed when it's 50°F will be 0.2 in. shorter at 0°F, and 0.2 in. longer at 100°F; 50 ft., or 600 in. \times 0.0000067 in. \times 50°F temperature change = 0.2 in.

An expansion joint (right) lets gutters move without stressing the seals. To accommodate movement, simply divide gutters over 50 ft. long in two, cap the ends and provide downspouts for each.



fall only to the lower roof, whose gutter will dispose of the rain. However, you'd be courting trouble. Even assuming you sized the lower gutter for the added runoff, concentrated water pouring onto the lower roof will erode the shingles and reduce their life span. Water that splashes onto the house's siding also can cause paint to peel and wood to rot.

The best solution is to put a gutter on the higher roof and to run its downspout to the ground. That solution may not be possible, for example, with a wraparound porch. In that case, if you don't mind the look, run a downspout over the lower roof and into its gutter. To drain the increased runoff, add an additional downspout to the lower roof's gutter.

If that's not feasible, you can simply drain the upper gutter's downspouts onto the lower roof! If you do that, though, be sure to drain it onto a splash block to avoid eroding the shingles. Even a cheap plastic splash block spreads out the flow. You can also custom-bend a splash block from sheet metal. Be sure to corrugate the bottom to disperse the water.

Roof valleys concentrate runoff, often to the point where it overshoots or splashes out of the gutter. The fix is to install a baffle, a sheet-metal corner that rivets inside the gutter's outside edge. Baffles typically rise about 2 in. higher than the gutter and block torrents from overshooting the gutter. Adding a downspout nearby will help water to drain quickly.

Hidden hangers install quickly

The best way of affixing gutters to the house is subject to great debate. I haven't found a universal answer, but here's some information to help you choose.

To make gutters easier to clean, my ideal hanger wouldn't cross the top of the gutter (photo p. 96). Brackets of this type cradle many half-round gutters and are available for copper K-style gutters. I couldn't find any for aluminum K-style gutters.

Most installers I spoke with use hidden hangers for aluminum K-style gutters. Some of these hangers are fastened with an integral galvanized-steel screw (photo 2, p. 99). This type clips to the back of the gutter and slips into the front channel. They're an installer's dream because they clip into place on the ground. There is no fumbling for fasteners on the ladder; the installer simply drives the preplaced

screws home. Hidden hangers don't support the gutter bottom, though. Their strength depends on gutter rigidity. To be certain hidden hangers will hold up, it's best to use them only on heavier 0.032-in. gutter stock. And be prepared for the steel screws to corrode eventually.

Other brackets are nailed or, preferably, screwed to the fascia and support the gutter from below. A strap snaps across the top of the bracket, locking the gutter in place (photo 3, p. 99). These straps may be stronger than the hidden hangers because they support the gutter top and bottom. Some tie to the house with straps (photo 1, p. 99) that extend onto the roof, useful if there is no fascia, particularly on replacement jobs where rafter tails no longer offer sound fastening.

Brackets that support the gutter from below can be time consuming to install. Depending on how the brackets are spaced, you might be able to fasten three brackets for each trip up the ladder. Then, up the ladder with the gutter, and one more trip for every three brackets to snap on the top strap.

Spikes and ferrules are the old standby

Spikes and ferrules are probably the most controversial fastening method (photo 4, p. 99) because older versions didn't work well and because they're tough to install. Spikes have evolved from the smooth galvanized versions that rusted and fell out of the fascia on my parents' house. The new spikes are ridged aluminum, hold pretty well and don't rust. They hold so well, in fact, that they're hard to pull without damaging the gutter. This holding power can be a problem should the gutter need to be removed, say, for painting the fascia. (For another method, see "Tools & Materials," p. 126.)

Starting gutter spikes takes some skill. With the fingers of one hand splayed around the gutter, the installer holds the spike outside the gutter and the ferrule inside. Holding a hammer in his other hand, the installer delivers a sharp blow that sends the spike through the gutter's face into the ferrule. Aluminum spikes bend easily, and a misaimed hammer blow can ruin a gutter. A misfire like this would happen to me only on the last spike in a 50-ft. gutter. Unless the house has 2x fascias, common on some new homes but not on old, the spikes have to enter the rafters. □

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