Rafter Cutting Basics

Understanding basic rafter principles is key to efficiently framing even the most complex roofs

by Don Dunkley

There are many ways to cut rafters. In more than 25 years of framing houses, I have learned a variety of techniques, from cutting rafters one at a time to production gang-cutting methods. But regardless how you produce all the rafters that go into a house, the basic principles remain the same for every method. Rather than get too involved in different cutting techniques, in this article I'll concentrate on what is required to lay out hip and common rafters, and describe only a few shortcuts for cutting and stacking the roof. This article follows "Simplified Roof Calculations" (3/99), in which I described how to calculate rafter lengths using the Construction Master calculator. The examples in this article use the same rafter lengths described in that earlier piece — those required for a standard 8/12 hip roof on a 22x57-foot building. Once again, the Construction Master serves as an indispensable tool for figuring each rafter cut.

Parts of a Common Rafter

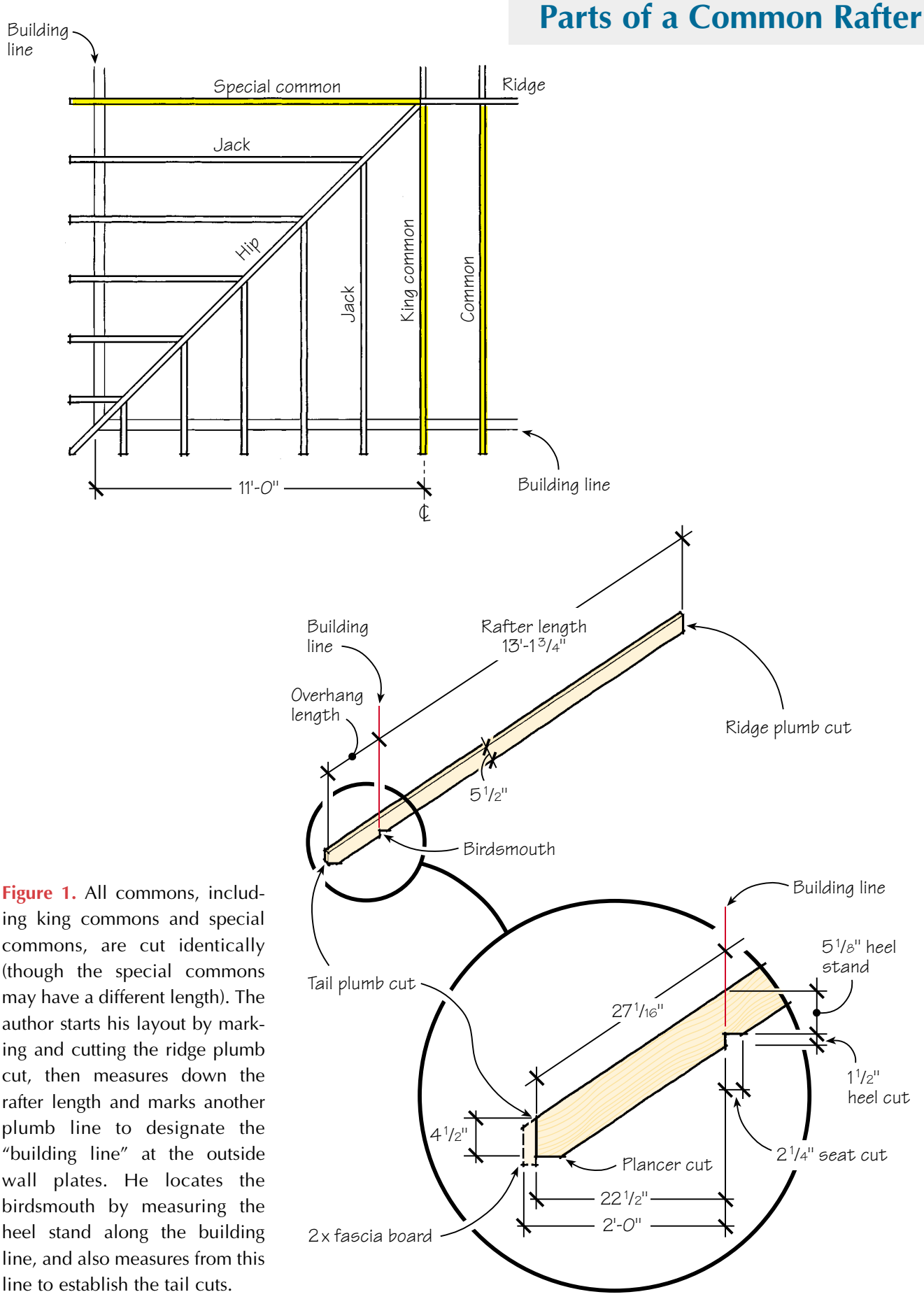

Figure 1. All commons, including king commons and special commons, are cut identically (though the special commons may have a different length). The author starts his layout by marking and cutting the ridge plumb cut, then measures down the rafter length and marks another plumb line to designate the "building line" at the outside wall plates. He locates the birdsmouth by measuring the heel stand along the building line, and also measures from this line to establish the tail cuts.

The Common Rafter

Let's start with some fundamentals. A common rafter has three essential parts (see Figure 1).

A ridge plumb cut. Cut as an angle on the rafter, the *ridge cut* is held plumb, or vertical, when the rafter is installed at the face of the ridge board. It represents the top limit of the roof rise.

A birdsmouth, for positive attachment to the outside walls. This is made of two cuts: a vertical *heel cut* for the outside edge of the wall and a level *seat cut* that allows the rafter to bear on the wall.

A tail cut, to define the overhang. This consists of a plumb *tail cut* that ends the rafter, and a level *plancer cut* that keeps the tail cut from sticking past the bottom of the fascia board. If there's no overhang, then the rafter ends at the building line. If there's no fascia board or gutter, the plancer cut is eliminated.

Figure 2. To speed layout on all commons and jacks, the author makes a rafter pattern. He attaches 1x along the top edge for easy alignment. Note that he leaves a gap in this 1x above the birdsmouth so he can find the building line mark on his rafter stock.

Common Rafter Layout

For accuracy, I use a framing square to lay out rafters. I use it initially to lay out a rafter pattern that contains all the necessary cuts for a particular set of rafters. I also use the Swanson Speed Square and the Swanson Big Twelve, a larger version of the Speed Square. But for my pattern layout, the framing square is key. It's also the best tool to use when starting out, since it gives you a visual representation of the unit rise and unit run.

Ridge plumb cut. To lay out a full-size common rafter on my example roof, I first look at my cut list and check to see what length material has to be used. In our example, the 11-foot run and 2-foot overhang calls for a 16-foot 2x6. With the framing square, I mark the ridge plumb cut (first making sure the rafter is labeled with the crown up). I place the cut mark as close to the end as possible. Of course, if the wood is split, you move down to avoid it.

Once marked, I make this cut. Then, hooking the tape over the long point, I pull down the rafter the calculated length of 13 feet 1 3/4 inches and place a mark on the top edge. From this point, I make another plumb line as I did at the ridge cut. This line represents the *building line* — the outside edge of the wall.

Common birdsmouth. To make the birdsmouth, I must first determine how deep the cut will be. To provide adequate bearing on the wall plates and to leave enough uncut material to support the overhang, I go by this rule of thumb*: At least two-thirds of the rafter stock must remain above the birdsmouth.* The size of the birdsmouth changes with the slope of the roof, so each roof pitch will have a different seat configuration. In this case, the two-thirds rule calls for a minimum 4 5/16 inches of the rafter above the outside wall plate. This distance is called the *heel stand*. The remaining 2 5/16 inches — the *heel cut* — falls below the plate line. However, this deep heel cut covers most of the double top plate, leaving too little nailing for the exterior sheathing. So I increase the heel stand to 5 1/8 inches, leaving a 1 1/2-inch-deep heel cut. This results in a 2 1/4-inch seat cut.

Keep in mind that the two-thirds rule relates to tail strength. Adding to the heel stand increases this strength. It is not necessary for the seat cut to bear on the full width of the top plate, but make sure you have at least 1 3/4 inches of bearing.

To lay out the birdsmouth for cutting, I measure down the building plumb line and make a mark at 5 1/8 inches. Then, at this point, I draw a line at 90 degrees from the building line in the direction of the ridge cut. This is the *seat cut* line. It represents the amount each rafter will bear on the plate.

Common tail cuts. In the example, the plans call for a 2-foot overhang. All overhangs are measured on the horizontal projection from the building line. Don't just add 2 feet to the rafter length and call it a day; the actual rafter length needed will be longer. I use the Construction Master to figure this distance: 2 feet 4 7/8 inches — the true overhang length along the rafter.

If fascia is used, deduct its thickness from the run. If the fascia board is a 2-by, then the run would be 22 1/2 inches, giving a tail length of 2 feet 3 1/16 inches inches (again, using the Construction Master). I measure down 27 1/16 inches from the building plumb line along the top of the rafter and draw another plumb line. The rafter ends at this tail plumb cut.

Parts of a Hip Rafter

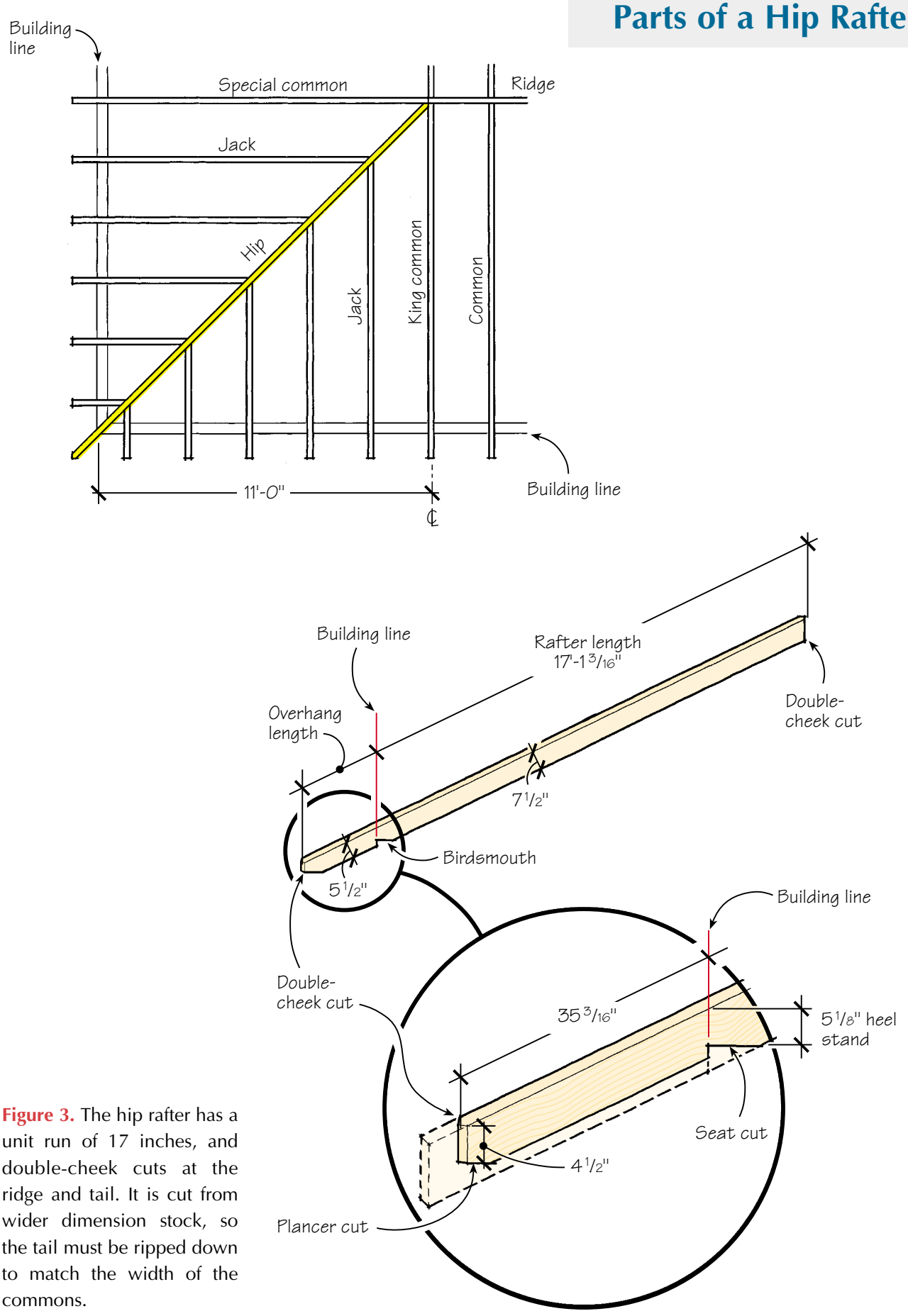

Figure 3. The hip rafter has a unit run of 17 inches, and double-cheek cuts at the ridge and tail. It is cut from wider dimension stock, so the tail must be ripped down to match the width of the commons.

For the plancer cut, if there is one, I check out the size of fascia board. In this case, it's a 2x6. Because 2x6 fascia is the same width as the rafter stock, the plumb cut on the tail will be wider than the fascia, so we need to trim down the tail cut to allow the fascia to hang below the tail cut. A 1-inch reveal is common, so I measure down 4 1/2 inches on the tail cut and draw a line 90 degrees to the tail plumb cut for the plancer cut.

Making a Rafter Pattern

Once the birdsmouth and overhang are marked, I can make my cuts, giving me a completed common rafter. To simplify and speed production, I use a rafter pattern. The pattern is a template that I usually cut from plywood (for lightness) or from a scrap of rafter stock (for expedience). This pattern has a plumb cut at the top, a birdsmouth laid out 12 inches down, and an overhang cut at the end. I nail 1-by scrap along the top edge (forming a "T" in cross-section) so the pattern can be laid over the rafter stock and held flush to the top edge. A 2-inch gap in this 1-by, located at the birdsmouth plumb line, allows me to reference the top of the building line for proper alignment (Figure 2, page 57).

Hip Rafter Layout

A hip rafter is always cut from wider stock than the common rafter. This gives additional strength and allows extra width for nailing on the jacks. I make the ridge cut first. On a hip, the ridge cut is a little different from the commons because it must fit between two commons (Figure 3). This cut, called a *double-cheek cut,* has a 45-degree bevel on each side.

Cutting a double-cheek cut. To make a double-cheek cut, I place the framing square on the lumber so the tongue is set at 8 and the body is set at 17 (the run of a hip), and scribe a ridge plumb line down *both sides* of the 1 1/2-inch-wide tongue (Figure 4). Then, with the table of my saw set at a 45-degree bevel, I cut along the first (outside) line, making the long point cut. I leave the line

Figure 4. To make a double-cheek cut on a hip, the author lays out a plumb cut with a framing square. He marks both sides of the 1 1/2-inch tongue on the square (above). Leaving the line visible on the board, he then cuts along the outside line with the saw set at a 45-degree bevel, moving from the top edge of the rafter towards the bottom to cut the long point (middle). Finally, he cuts in the opposite direction to cut the short point, resulting in a near-perfect double cheek cut (left).

Laying Out a Double Cheek Cut in Wide Stock

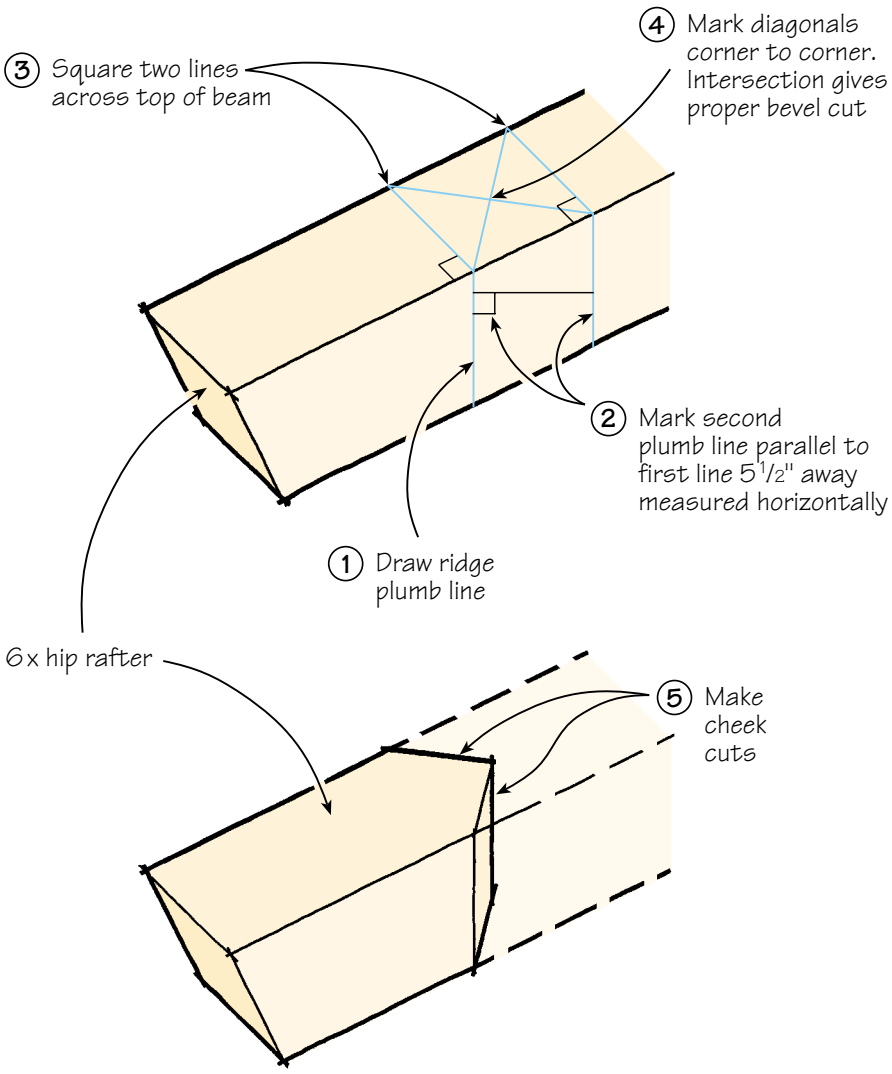

Figure 5. Because a double-cheek cut does not form a true 45-degree bevel, when using wide beam stock for the hip, the cheek cuts must be laid out accurately. First draw two plumb lines, with the spacing between them equal to the width of the stock (5 1/2 inches in this example). At the top of each plumb line, square across the top edge of the beam, then join the two squared lines with diagonals. The angle formed by these two diagonals defines the proper bevel.

intact. I then cut in the opposite direction along the other line, making a short point cut. Again, I leave the line. This maneuver results in a pretty good double-cheek cut.

Not a true 45. It's important to note that this double-cheek cut is not a true 45-degree bevel, even though the saw is set at 45 degrees. Before power saws, this cut was made with a handsaw. But if a 45-degree line was made across the top of the rafter, and then cut with a handsaw, the resulting bevel cut would not fit properly. This is because the 45-degree bevel should be marked perpendicular to the ridge plumb line. This can't be done laying a Speed Square or tri-square on the top edge of the board and drawing a 45-degree line. This also goes for the jack rafters.

Since modern roofs use 2-by stock and are cut with power saws, a carpenter can easily overlook this. But if you're not aware of the issue, problems will arise when you use wider beam stock for the rafters, or when bevel cuts go beyond 45 degrees, as in the case of irregular roof jacks, turret jacks, and bay rafters. In these situations, the carpenter must understand basic rafter principles. For example, to lay out the ridge plumb cuts for a 6-by hip beam, I first scribe the plumb line as usual (Figure 5). Next, at a 90-degree angle from the ridge plumb line, I measure out the thickness of the stock (5 1/2 inches), and place a mark. I then plumb through this mark with another ridge plumb line, giving me two plumb lines 5 1/2 inches apart on the perpendicular. Across the top of the beam, I square two lines, one from the first plumb line and one from the second ridge plumb line. The intersection of two cross-diagonals between these two lines describes the proper bevel cut.

This can be done more efficiently with a framing square and the Construction Master. First, find the unit length of diagonal for the hip rafter at the pitch being used. Using the calculator, enter 8 Inch, Pitch, 12 Inch, Run, then push the Hip/Val key, which will display 18 3/4 inches. This is the *unit diagonal length* of the hip with a 17-inch run. Since the tongue of the square is

only 16 inches long, divide the numbers in half to get 9 3/8 inches and 8 1/2 inches. Place the framing square on top of the beam holding the tongue at 9 3/8 and the body at 8 1/2, and mark along both sides of the tongue. This is the proper bevel cut (it happens to be a 47.8-degree angle).

Some of the better framing squares will have tables printed on the blade that refer to this cut. They are usually referred to as "side cuts for a hip."

Hip Birdsmouth

Once I make the double-cheek cut, I hook my tape over the end of the long point, measure down, and mark the top of the hip at the calculated length, 17 feet 1 3/16 inches. Here, I make an 8/17 building line plumb mark. This designates the top of the building line and marks the position of the birdsmouth. Next, using the same heel stand measurement that I used for the commons, I measure down 5 1/8 inches. At this mark, I draw a perpendicular (90-degree) seat cut line in the direction of the ridge. (When laying out birdmouths, always measure down from the top of the rafter. That way, if different widths of rafter stock are being used on the same roof, the tops of the rafters will plane in together.)

Dropping the hip. After I lay out the birdsmouth, I must "drop the hip." This is done so the top edge of the hip will plane in with the other rafters. Because the hip rafter sits on the outside corner at a 45-degree angle from the other rafters, the outside face of the hip projects from the wall by half its thickness. If you don't account for this, the top corners of the hip will stick above the roof plane. To correct for this, the seat cut must be cut a little deeper to drop the hip down.

To lay this out, I first measure along the seat cut line 3/4 inch (half the thickness of the hip), starting from where the seat cut line meets the building plumb line (Figure 6). I then draw a second plumb line that goes right through this 3/4-inch mark. From the top of this new plumb line, I measure down the heel stand of 5 1/8 inches,

Dropped Hip Layout

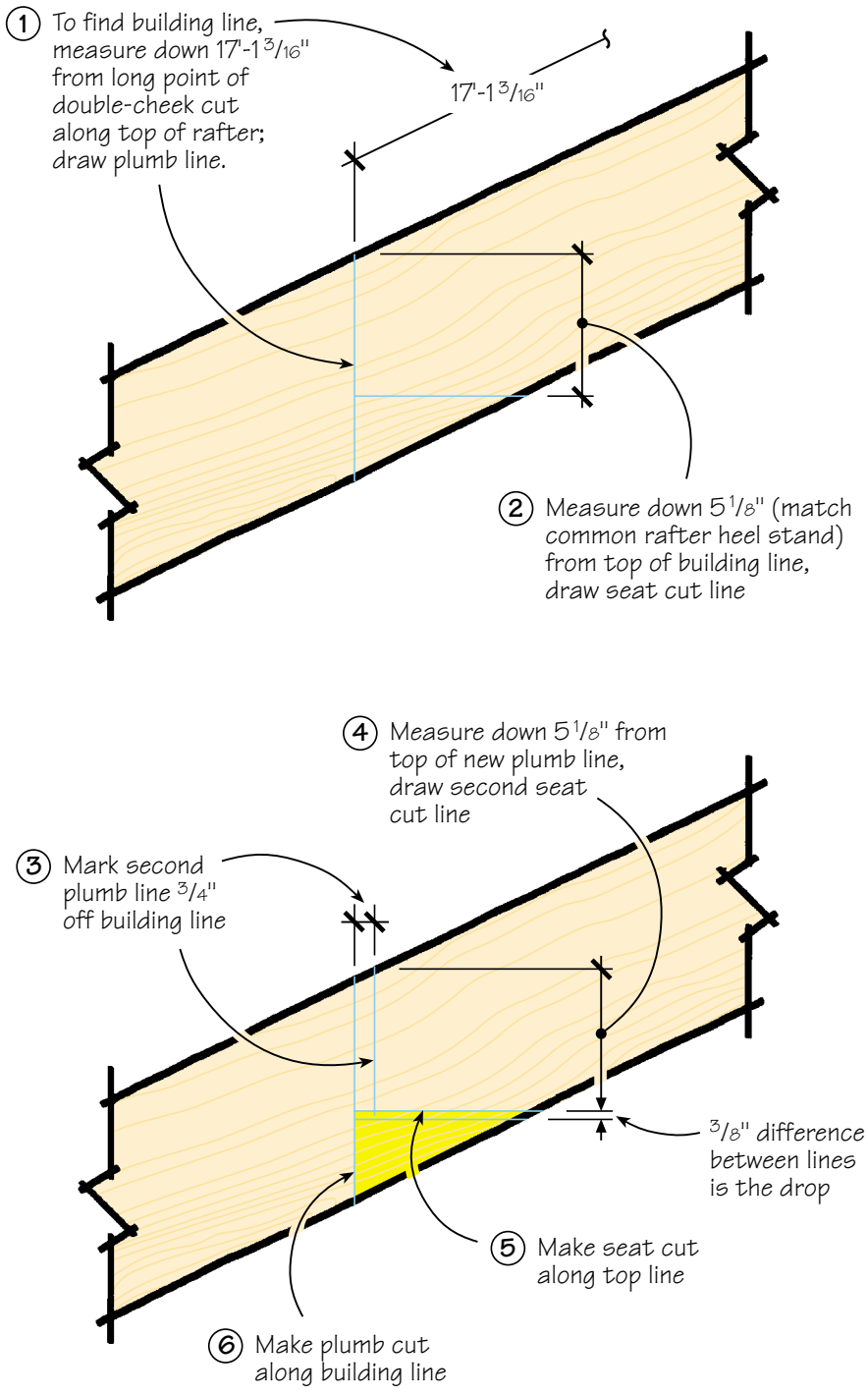

Figure 6. To ensure that its edges don't protrude into the roof plane, a hip rafter must be dropped, by cutting a deeper seat cut. To find the depth of this cut, start at the building line, measure 3/4 inch perpendicular to this plumb line, and draw a second plumb line. Measure off the heel stand along this second line, and draw a perpendicular line towards the ridge. Make the birdsmouth cut at this second seat line, but along the first building line.

Laying Out and Cutting a Hip Tail

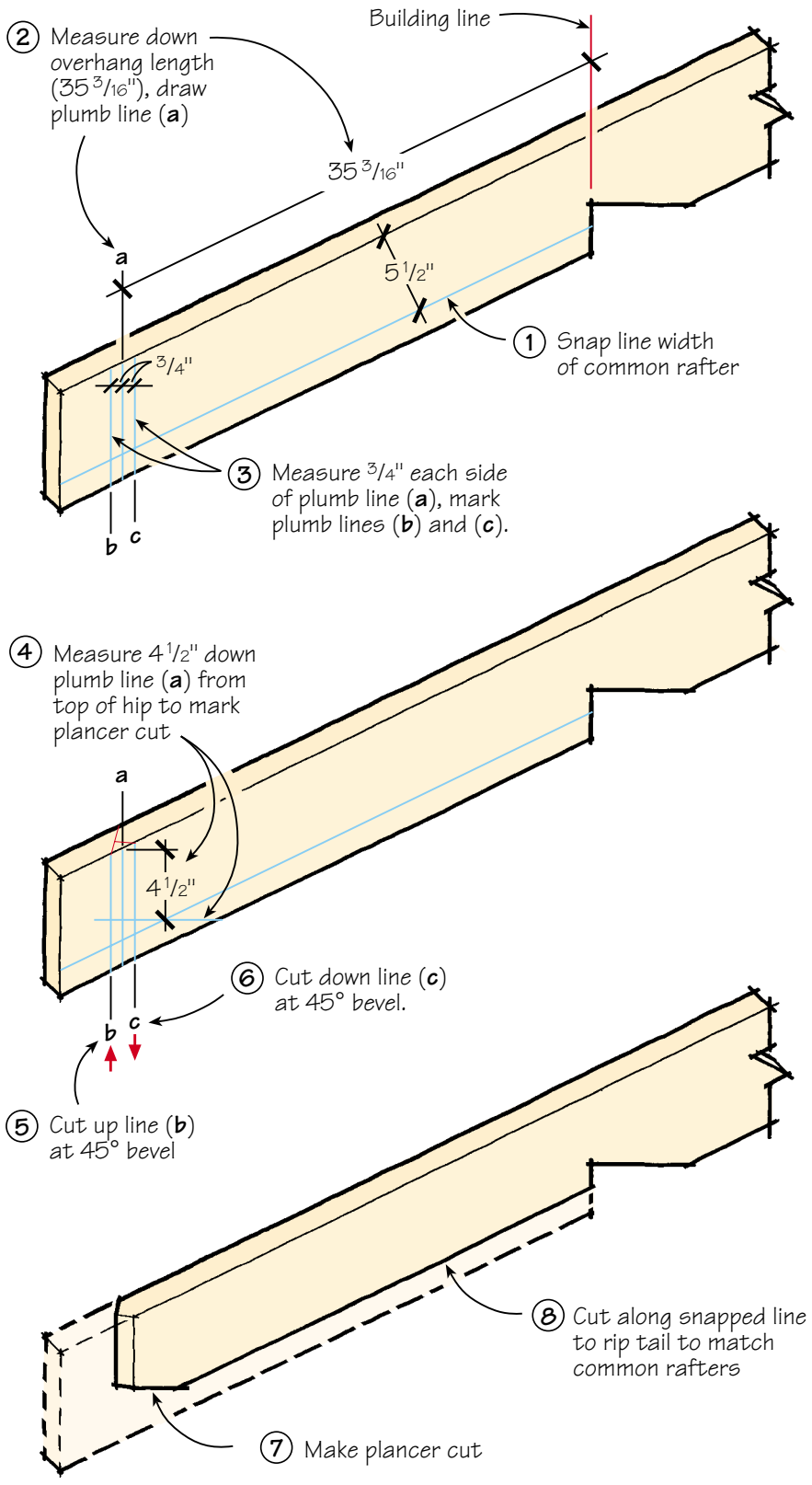

Figure 7. Follow the sequence shown when cutting the tail on a hip; otherwise, you will cut away reference lines needed for subsequent cuts.

make a mark, and draw another level seat cut line through this point going back towards the original birdsmouth. The 3/8-inch difference between the two seat cut lines is the *drop* for a 2-by hip on an 8/17 pitch. (This drop distance varies with the thickness and pitch of the hips, so this procedure must be done on each different roof.) The second (top) seat line is the actual cut line, so I scratch out the *first* (bottom) seat cut line and the *second* plumb line.

Hip tail cuts. Before cutting the birdsmouth, I lay out the hip tail (Figure 7). Because the hip is cut from wider stock, the tail that projects into the overhang must be ripped down to match the width of the commons. For now, I snap a chalk line on the tail part of the hip marking the new tail width, but I'll hold off making this cut.

I first figure the length of the hip overhang. Using the Construction Master, I enter the 8-inch pitch, the 22 1/2-inch run (for the horizontal projection minus fascia), then hit Hip/Val, which will display 35 3/16 inches. I measure down the hip from the building line this distance and draw a tail plumb line. On each side of this plumb line, I mark half the thickness of the hip, or 3/4 inch, perpendicular to it, and draw two more plumb lines through each of those marks, as in Figure 7. This gives me a total of three plumb lines at the tail. From the top of the hip, I measure 4 1/2 inches down the original (middle) plumb line to mark the location of the plancer cut, and draw a perpendicular line in the direction of the birdsmouth. (Make sure the plancer cut line is drawn before the tail bevel cut is made. If you don't, you have to measure down the center of the tail bevel, cut square over to the face, and then lay out a perpendicular fascia cut line).

To cut the tail, I set the saw at a 45-degree bevel and make a double-cheek cut, just as I did for the ridge plumb cut. I cut down the furthest (outside) plumb line first, skip the middle line, and cut in the opposite direction along the third line. I then make the fascia level cut and finish off the tail by ripping the chalk line marking the width of the tail.

Jack Rafters

Jacks are similar to commons as far as the birdsmouth and tail cuts. The difference is in the plumb cut at the top. The jack plumb cut is a compound bevel that fits tight against the side of the hip. Jacks are both right-hand and left-hand so they can sit on opposing sides of the hip. In our example, each of the four hips has two pairs of jacks, or eight of each length.

Because the jacks come in pairs and diminish in length as they progress down the hip, I stack the rafters in sets of eight, mark them for length, then scribe for the birdsmouth and tail cuts. In this method of production cutting, I add the tail length to each jack length to get a rough length for each of the various sets of jacks.

Starting with the longest jacks, I load up the sawhorses with eight rafters, crowns up. (If I'm using a cutting bench, I'll place the whole set of jacks from longest to shortest.) I square up the ends so the rafters can be measured together, and designate the pairs of rafters by marking four with a diagonal slash from the top right-hand side and four from the top left-hand side (Figure 8). I hook my tape over the top of the rafter on the outside of my stack, and measure down 10 feet, $9\frac{7}{16}$ inches — the length of the first, or longest, jack — and make a mark for the building plumb line. I do the same to the outside rafter on the other side of the stack, then draw a square line connecting the two marks. I now have all eight of the rafters of that set marked for length.

I lay out each jack by laying it flat according to the diagonal mark I placed at the end — the diagonal slash indicates the long point and must face up. I use the rafter pattern to scribe the plumb cut, building line, birdsmouth, and tail cut. The tails and birdsmouths are cut just like those on the commons; the plumb cheek cuts at the top are cut with the saw set at a 45-degree bevel.

Figure 8. The author cuts the jacks for all four hips in a roof in sets (four hips require eight jacks of each length). The photo above shows the setup for the longest jacks. Similar setups would be required for each of the five jack lengths in the example roof.

Don Dunkley *is a framing contractor in Cool, Calif., and a contributing editor to* JLC.