

Chapter 8

Underscribing

It is not all that difficult to get notches and grooves to fit tightly the day they are scribed—all it takes is a steady hand with the scribe and then with the chainsaw. The *real* challenge for handcrafted log construction is to keep those fits tight over time—over the life of the building, which can be hundreds of years.

And, in particular, we need to keep the fits tight the first five years — while the logs are drying and shrinking, and the house is *settling*. The problem is that as the logs dry out and shrink in diameter, the corner notches get a bit loose.

The cause of this is: logs (and all wood) shrink substantially in diameter, but hardly shrink at all in length.

And, when corner notches get loose, then fits become worse because the logs are free to twist. Tight corner notches restrain logs, and help keep them in place, and prevent them from tipping or twisting, but as logs dry, shrink, check, then the notches get loose. Loose notches allow the logs to twist, which causes gaps to get even bigger.

So, if we can prevent the corner notches from getting loose, then we have a much tighter home now and in the future.

There have been two approaches tried by handcrafted log home builders to keep corner notches tight over time:

- 1) Some have tried altering the shape of the notch itself, so that it tends to tighten up as the logs shrink—the *shrink-fit notch*.
- 2) The other approach is to make the notches *extra-tight* at first, knowing that the corner notches will be shrinking, . This method is called *underscribing*.

CHAPTER TOPICS

Underscribing keeps corners tight

- Scribe settings for notch and groove are different
- All the weight starts on the notches

How much to underscribe

- New and old, compared
- Radial shrinkage
- Sill logs
- Climate and moisture content affect underscribe amounts
- One-notch logs
- Make sure there are no future hang-ups
- How long will there be gaps?
- Settling

Shrink-fit notches

Hint

You will find much more about underscribing in Boxed Set 1 of my DVD series, including a good animation of a notch shrinking.

Underscribing Keeps Corners Tight

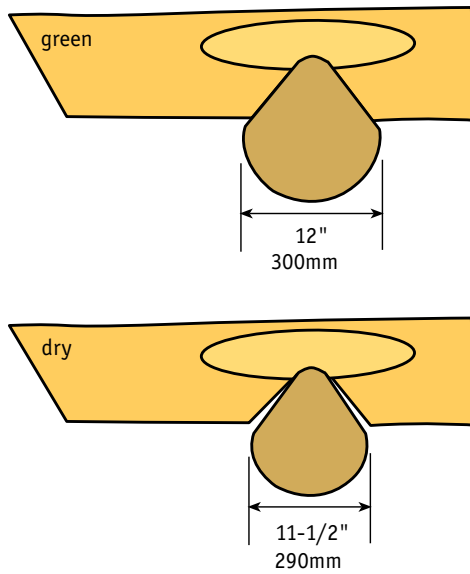


Figure 1: When the logs are green, the notch fits perfectly (top); but when the log below shrinks in diameter, the hole in the log above (the notch) stays the same width. The hole is still 12" when the logs are dry, but *the log below is no longer big enough to fill the hole in the log above.*

This happens because logs shrink significantly in diameter, but do not shrink much in length.

The log above is not shrinking in length (the notch stays about 12" wide); but the log below shrinks 1/2" in diameter, and so it isn't big enough to fill the 12" hole.

Disc 1, Box 1 of my DVD series, *Building Log Homes* has a time-lapse animation of this happening.

Starting in 1982, Del Radomske, a log home builder and teacher in British Columbia, began experimenting with ways to keep corner notches tight over time. He knew that his logs fit perfectly when they were green, but noticed that they did not fit very well when the logs eventually dried. In his buildings, he noticed, the grooves stayed tight and most of the corner notches got loose (*Figures 1 & 2*).

Radomske imagined that if he could take a dry log building apart, remove a fraction of an inch from all the long groove edges, and then put the walls back together, then the notches and the grooves would all be tight. He wanted to remove the wood that was preventing the corner notches from fitting tightly after the building had finished shrinking and settling.

Obviously, taking log homes apart in 4 or 5 years is not practical, and Del's great insight was that if he took a little extra wood off the grooves *at the start*, then when the logs eventually dried this would accomplish the same goal. As he saw it, the grooves were too tight in log homes after settling was complete—they were so tight that they wouldn't let the corner notches slide down the saddles, and so the corner notches got gaps (*Figure 2*).

Underscribing is a technique that helps solve this problem: the notches and grooves are scribed using slightly different scribe settings (*Figure 4*). Before Radomske, logs were always scribed with one scribe setting. After Radomske, we now use one setting for the groove, and a slightly different setting for the same log's notches. The result has been significantly tighter corner notches over time.

Because of the way Del first visualized the problem—"the long grooves are too tight"—he calls this technique *overscribing* (he *opens up* his scribers to scribe the long grooves). I call the technique *underscribing* because I scribe the groove first, and then I *close down* my scribers so the notches will be a bit tight—I *underscribe* the corner notches. *I leave a little 'extra' wood in every notch.*



Figure 2: This building was not underscribed. As logs the logs dried, the long grooves stayed tight, while corner notches got gaps. The even width of the notch gaps prove that the scribing and cutting was carefully done: the gaps are *not* from poor craftsmanship, they're from normal and expected shrinkage. Underscribing solves this problem—underscribing helps keep the notches tight over time.



Overscribing the groove and underscribing the corner notches are two names for the same thing. The long groove (*lateral*) of the new log is scribed, and then the scribers are closed down a small amount, and the log's corner notches are scribed with a slightly smaller setting. This leaves a little “extra” wood in the notches. The difference between the groove scribe setting and the notch scribe setting is called the *underscribe* (Figure 4, & Figure 5.c, on next page).

Scribe Settings for Notch & Groove are Different

Before underscribing, we used to scribe each log with *just one* scribe setting—the notches and groove got the same scribe setting. But this made the notches gap when the logs shrunk. Radomske tried using two different settings, and he started out small at first—a $\frac{1}{8}$ " (3mm) gap in the grooves. By the time he had two rounds on the building, he reported, the $\frac{1}{8}$ " gap in the grooves had already closed—the logs were visually tight because the notches had compressed into the saddles enough to close the small gap in the grooves. And he found that $\frac{1}{8}$ " of overscribing was not enough to keep the notches tight over time (4 or 5 years). Del built another house with $\frac{1}{4}$ " (6mm) underscribe, and watched it for years. Then he tried $\frac{3}{8}$ " (10mm) and he was getting better results. Underscribing was born.

All the Weight Starts on the Notches

At first, in an underscribed building, all the weight of the building is on the notches, and not much is on the grooves. As the logs dry and shrink, weight is slowly and gradually transferred from the notches and is shared with the grooves.

As some of the weight is transferred off the corners, the wood of the saddle rebounds, keeping the notches tight. In order for underscribing to work, the corner notches must withstand great weight without crushing. Notch edges must be so strong that the wood of the saddle is compressed (Figure 5.a). **Compressed** wood will rebound, while **crushed** wood is forever crushed (Figure 5.b).

Underscribing also requires that the notch slide down the saddle to a new position that is as wide as its original position, *before* it shrank. In order to slide, there must not be a hang-up at the top of the notch. To allow for sliding, either we leave a gap at the top of the notches, or we leave a wood seal that is so thin that it can easily crush and never cause the notch to hang up (*compare these two methods—they are shown in Color Figure C-22 and in Figure 15 on page 123*).



Figure 3: The groove was scribed, then the scribers were closed down slightly, and now Olaf is scribing the notch. The notch scribe line is a little above the groove scribe line—the difference in height is the underscribe amount.

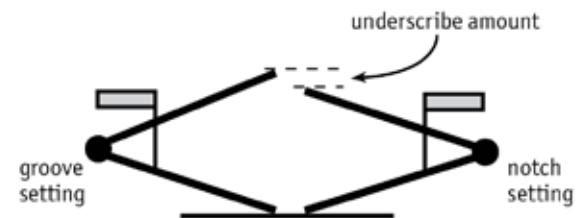


Figure 4: Find the widest gap between two logs and set your scribers at that point—this is the groove scribe-setting. Scribe the entire long groove. Then close the scribers a bit and scribe the corner notches. The difference between the groove setting and the notch setting is called the *underscribe*.



Figure 5.a: A properly compressed saddle. The notch of the log above has compressed the wood of the saddle. This wood will rebound over time, and help keep the notch tightly fitted as the logs dry and shrink.

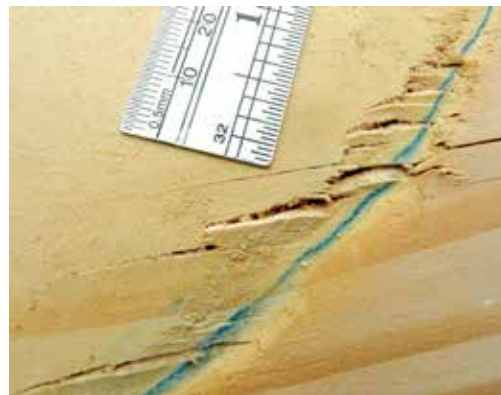


Figure 5.b: Too much underscribe ($\frac{7}{8}$ " (22mm)). The wood of the saddle has crushed and will never rebound. This is an underscribing failure.

How Much to Underscribe

The amount of underscribe you should use depends on: 1) the diameter of your logs; and 2) the amount of radial shrinkage your logs are expected to have from the time you scribe them to the time the logs reach equilibrium moisture content (EMC) with the local environment.

It takes about 5 years for logs to come to equilibrium with local conditions—much more on this topic in Chapter 9— *Settling*. Right now, we just need to estimate how much diameter your logs will lose as they dry out over the first 5 years, or so.

New . . . and Old . . . Underscribing, Compared

In earlier editions of this book I described underscribing pretty much as I learned it from Radomske. But, starting with the 2011 edition, I made significant changes, and I want to tell you why.

With Radomske's underscribing methods, notches that had more weight on them were to get larger underscribe amounts; and notches that had less weight on them were to get smaller underscribe amounts. These were core principles of Radomske's method.

But these methods did not work for my Accelerated Log Building method. In 1999 I started to build log home shells with an entirely new method that I patented, called *Accelerated Log Building*. I soon found that I could not use traditional underscribe methods: I could not use the underscribe amounts in the 2006 edition of this book. I could not find a way to apply the original underscribe method of using a larger underscribe amount on long logs, less underscribe on logs that have lots of notches, or using less underscribe the higher the log is up the wall.

But . . . I did not immediately understand *why* Radomske's original methods wouldn't work for Accelerated. If the old underscribe methods were correct, then they *should* have worked for both one-log-at-a-time methods and my Accelerated methods. I hate an unsolved puzzle, so I started working to try to understand what the problem was. I started testing in 1999, and after 14 years of testing, I became certain that I have a better underscribe method. It is also simpler to use, and it works better for both one-log-at-a-time log construction and Accelerated building methods.

My new underscribe method is based only on log shrinkage, and is *not* based on weight or compression (which varies with log length, number of notches, and the height of a log in the walls).

The 2006 and earlier editions of this book considered *both* shrinkage and compression, and had a chart that reflected the impact of both. But now I use *only* shrinkage when deciding how much to underscribe. And I get substantially better results: tighter fits over time. My new underscribe method works better.

To state the new method clearly: I am now using only one underscribe amount for an entire house. No matter how many corners, no matter how long or short the logs, and no matter whether a log is low or high on the wall, I am using just one underscribe amount for all the corner-notches in a house. The underscribe amount is based on radial shrinkage and diameter of the logs; and my long-term goal is to have the corner notches slightly tighter than the long grooves.



Figure 5.c: We use 3 scribe settings for each log. Always start by finding the long groove setting (LG), and scribing the groove. Then close down the scriber for the notch (N) setting (underscribe). Finally, open the scriber wider and scribe the flyways (Overhangs —OH).

Hint I am using just *one* underscribe amount for **ALL** the corner notches in a building.

Radial Shrinkage

Look up the tree species you are using in the *Wood Handbook* (available for free download from my website or from the USDA Forest Products Laboratory). In Table 3-5 find the radial shrinkage from green to oven-dry for your species. Next, find the equilibrium moisture content (EMC) for your local climate. On page 141 of this book there is an EMC map of the lower-48 of the USA, and from my website you can download a publication that has EMC data for most the world: www.LogBuilding.org then, click on the 'free info' page

Next, you need to reduce the radial shrinkage amount you find in Table 3-5, because your logs are not going to dry to 0% moisture content (because 0% is *oven-dry*)—your logs are going to stop drying when they get to your local EMC. EMC is usually between 4% and 13% moisture content, and depends on your location and your local climate and humidity.

As an example, if I am using Eastern white pine, total radial shrinkage is 2.1% (from Table 3-5 of the *Wood Handbook*). And, if I am building a house in a location that has 10% EMC, then my logs will not shrink 2.1% (which is the total shrinkage from 30% to 0% moisture content), they will shrink only about 1.4% (the shrinkage from 30% to 10% moisture content).

An example using white pine drying to 10% is shown to the right. The formula always uses 30% as the starting moisture content because wood does not shrink until it gets drier than the "fiber saturation point" (FSP), and FSP is about 30%.

Now, apply the 1.4% shrinkage to the log diameter: a 20" diameter white pine log that shrinks 1.4% will lose a bit more than 1/4" of diameter (*in metric*: a 51cm white pine will shrink about 7mm) by the time it gets to 10%MC. Because I want the corner notches to be tight, and compress slightly into the saddles *after* shrinkage is done, I'd use 3/8" (9mm) to underscribe all the notches of this example.



Figure 6.a: Sill logs, showing the underscribe amount. For sill logs, the difference in height between the three-quarter-sill-log flat and the half-sill-log flat is the underscribe amount.

Expected shrinkage = change in MC divided by FSP, times total shrinkage

Our example:

$$\text{Expected shrinkage} = \frac{(30\% - 10\%)}{30\%} \text{ times } 2.1\% = 1.4\%$$

20" diameter times 1.4% = 0.28" (about 1/4")

51 cm diameter times 1.4% = 7 mm

Sill Logs Helped Me Understand Underscribing

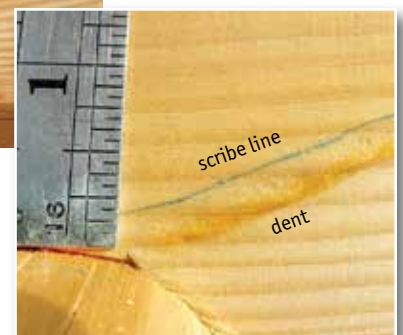
Although they have no grooves, you still need to underscribe the notches of the three-quarter-log sills where they cross over the half-log sills. In the 2006 edition of this book I noted that I was getting better results if I underscribed the three-quarter-log sills only *half* of the amount shown in the chart in my 2002 book.

As it turns out, this was one of the clues as to how much underscribing should be used. It just took me a few years to realize it! Let me tell you about that mini-mystery, and what it turned out to mean.



Figure 6.b: In the building yard, about 100% of the weight of the building is on the notches, and very little weight is on the grooves. In this photo you can see that the notch has compressed the saddle, and this is the result that we want.

Here you can see that the notch slid about 1/4" (6mm) down the saddle. In the detail picture, the scribe line is above, & the dent made by the notch, as it slid down the saddle, is below.



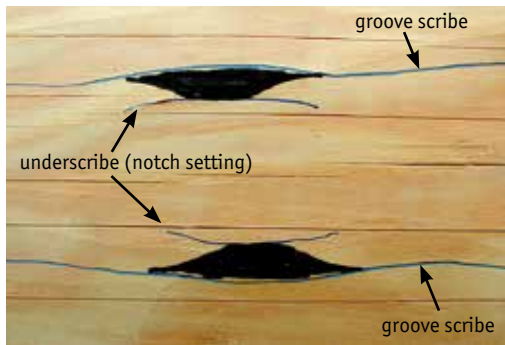


Figure 7.a: Tabs can be scribed to hold up underscribed logs at the right gap. The short scribe lines inside the groove were scribed with the notch scribe setting (underscribe). I marked the wood that is to be left as tabs with a black felt pen to make them easy to see.

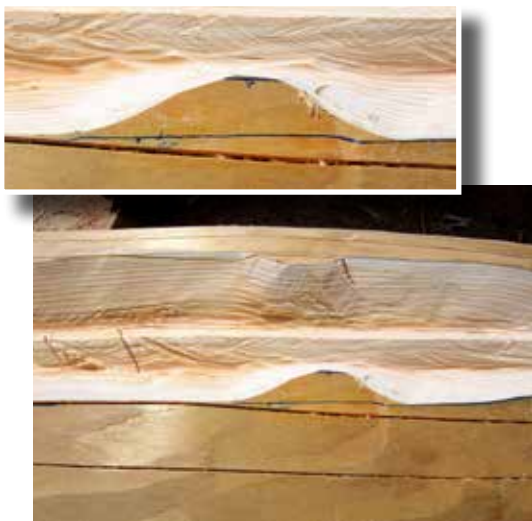


Figure 7.b: Tabs in a long groove that has been cut and sanded. (This is not the same log as Figure 7.a.) These tabs are about 1 inch (25mm) long.

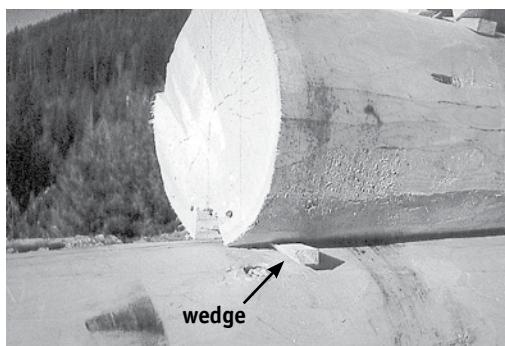


Figure 7.c: Wooden shims or wedges can hold up the end of the log that has no notch—this keeps an even gap in the groove from end to end. This is a substitute for tabs.

Hint You will find much more about tabs and one-notch logs, in Boxed Set 1 of my DVD series.

The logs that I normally use have 12" (30cm) top diameter and 18" (46cm) butt diameter, and Douglas fir logs have radial shrinkage of about 2.7% from green to my local equilibrium moisture content. With 'original' underscribing I had been starting my buildings with about $\frac{3}{4}$ " (18mm) of underscribe, but, I had been giving the sill logs of my buildings *half* this amount, $\frac{3}{8}$ " (9mm) of underscribe (Figure 6.a). Over time, by observing my buildings as they dried, I realized that the sill logs needed a much smaller underscribe amount than all the other wall logs. I didn't know why, I just knew that $\frac{3}{4}$ " (18mm) was way too much for my sill logs.

It turns out that $\frac{3}{4}$ " was actually too much for *all* the notches, not just too much for the sill logs. And $\frac{3}{8}$ " (9mm) of underscribe is about right for the whole building. Now, in every corner, and from the bottom to top of the walls—all my notches get about $\frac{3}{8}$ " (9mm) of underscribe. (Keep in mind that these amounts are for my logs, and in my climate.)

Climate & Moisture Content Affect Underscribe Amounts

There are other conditions that affect the amount you should underscribe, but it is difficult to quantify exactly how much effect they have.

Use less underscribe if you are using dry or dead-standing logs—but you must test the logs with an electronic moisture meter to determine how much drying they still have left before they reach equilibrium. Never use the weight of wood (*it feels lighter now*) to guess at moisture content (MC). The amount of underscribe is proportional to moisture content as long as the wood has a moisture content that is less than fiber saturation (about 30% MC). Logs that are 20% MC, for example, need a smaller underscribe amount than logs that are green (30%MC, or greater).

Underscribing is not an exact science, at least not yet. The basic underscribe comes from the table of radial shrinkage, which is then reduced by your local EMC (the driest your logs will ever get). The shrinkage you anticipate is then applied to your log diameters. But experience and observation also figure in. Underscribing definitely improves the fits over time, but it is difficult to calculate exactly how much a log should be underscribed when you consider all the variables: EMC, elevation, the starting moisture content of the tree, and the fact that all logs have two diameters: and the butt and tip ends will shrink slightly different amounts because they have different diameters. To get the underscribe amount we make a calculation, and luckily this is good enough. Underscribing works: it *definitely* keeps corner notches much tighter over time.

One-Notch Logs Need to be Held Up

Some logs have less than two notches—for example, logs that extend from a corner to a door opening; and some logs have no notches at all, like those between a door and a window. You need a way to hold up the ends of logs like these. The log pieces between door and window openings do not have a corner notch, and so are never underscribed (more about what we do with log islands is on page 138).

For one-notch logs, one effective technique is to scribe small *tabs* at the end, or ends, that have no notch (I call them *log islands*). These tabs are portions of the long groove that are scribed with the same scribe setting as the notch (Figures 7.a, 7.b, and 7.d). The tabs prop-up these special logs, and keep an even gap in the groove. The tabs are conveniently cut off later when the door or window opening is cut to its final width.

The tabs can usually be about 1" to 2" (25 to 50mm) long, though you could make

them shorter for short logs. Instead of tabs, you can use wooden shims or pieces of conveyor belt at the log ends that have no notches (*Figure 7.c*). You can pull the shims out over time to keep the gap in the long groove even, but they usually just conveniently crush on their own as needed. If they do not crush fast enough, then use a reciprocating saw to cut them smaller over time. Tabs in door and window openings get cut off when the openings are cut to their final and full widths. By the time you have the roof on your log home shell, all the grooves should appear tight: the wedges all removed; or the tabs crushed or cut off.

Make Sure There Are No Future Hang-ups

You must be precise when scribing and cutting underscribed logs because there is no good way to test for the eventual fit, or to find possible *future* hang-ups.

When we scribed a log with equal scribe settings (that is, no underscribing) we could see exactly how it fits when we put the log on the wall. If there was a problem, we knew it immediately. But, when you put an underscribed log on the wall, the grooves are a bit loose (*Figure 8*), and there is no perfect way of knowing whether there is an extra bit of wood somewhere that will be in the way in four or five years.

You should use a scribe that marks both the top and the bottom scribe lines, not a scribe that holds only one pen or one pencil. You need *both* scribe lines in order to get the log back in exactly the right place. With both sets of lines, just match up the notch so it is sitting right on the scribe lines on the saddles at both ends.

How Long Will There Be Gaps?

The most common question about underscribing is: what do you do with the gaps in the long grooves? The answer is simple—there are *no visible underscribe gaps* by the time the roof is on the building.

There are some builders who use larger underscribe amounts than I do, but for my buildings, the gaps in the grooves are closing by the time there are 3 or 4 rounds of logs above them. The grooves are visually tight when there are about 4 or 5 rounds of logs in the walls. The long grooves of the top several rounds in a building start to appear tight after the roof is on.

When I was using the old underscribe methods, and was reducing the underscribe until it was only about $\frac{1}{16}$ " (less than 2mm) for the notches of the topmost logs, those notches opened up 5 years later because that was not enough underscribe to keep them tight. Now, with the new underscribe, I use the same underscribe amount all the way from the bottom logs to the top plate logs, and the notches high on the walls are now staying tight.

Settling Allowance is the Same

The shrinkage and compression in an underscribed building is identical to shrinkage and compression in a building that is not underscribed. This means that settling will also be the same—allow about $\frac{3}{4}$ " per vertical foot of logwork (6%). There is no extra weight to cause more compression, there is no extra shrinkage, and the safety factor is the same, and so the settling allowance is the same.

Header Logs over Islands

If you have been building a wall that has a *log island* (*Figure 10*, next page), then you need a trick to scribe the header log, or any full-length log, that spans from corner to corner over an island. The grooves of the island fit tightly—but the grooves near the corners (the one-notch logs) have underscribe gaps.

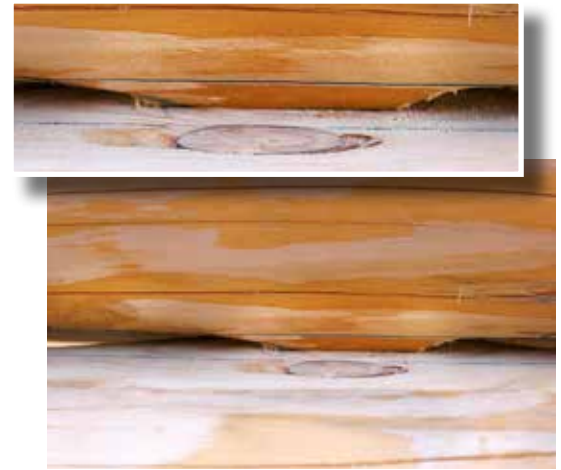


Figure 7.d: Close-up of a tab on a one-notch log. The purpose of the tab (or a wedge) is to keep the long groove's underscribe gap open. Here you can see the gap to the left and right of the tab. Over time, the tab crushes, and the underscribe gap will decrease towards zero. If needed, you can reach in with a saw, and cut the tab shorter to keep the gap in the groove equal along each log's length.

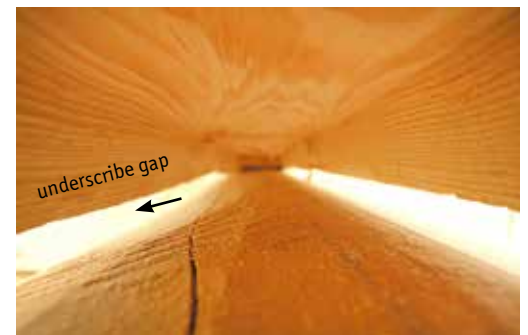


Figure 8: Looking down the inside of an underscribed long groove. No future hang-ups in sight here. There is a long, consistent-size gap in the groove of the log. The height of this little gap is equal to your underscribe amount. The gap closes down and becomes tight—when the corner notches compress into the saddles as you build and add new layers. (Like most builders, we install gaskets and wool into the grooves *after* we take the log shell apart, and as we prepare it for transport to the foundation. The grooves are empty (like this) when the log home shell is in our yard.)

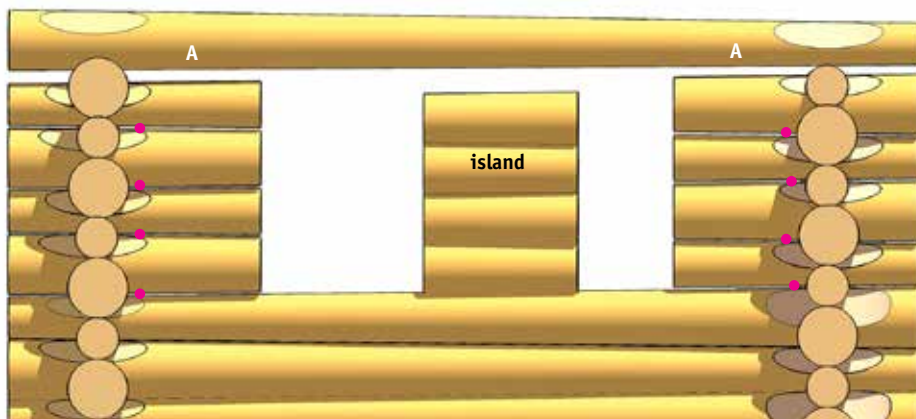


Figure 10: How to find groove scribe settings for a long log over an island—the island logs have NO underscribe gaps, and you can see the island is shorter in height because of that. Add up the gaps at the red dots—this is TG (see text). Find the widest gap at A (left and right), and set scribe so groove would be 3" (75mm) from edge to edge (this is the **Initial** Scribe setting). Now, open scribe to = TG + Initial (this is the **Adjusted** scribe setting). Test the Adjusted setting above the island—would the groove be **more** than 3" wide? If yes, then scribe island's long groove with the Adjusted setting; and scribe both A-ends with Initial setting. But, if island groove would be **less** than 3", then ignore the adjusted scribe setting; open the scribe to make island groove 3" wide, and scribe the island's long groove. Then reduce this setting by the TG and scribe both A-ends long groove. Then, corner-notches are scribed with a setting that equals the setting used for grooves of A, minus your underscribe amount.

- 1) Adjust the free-end of one-notch logs so that the gap is the same height at their free-end as the gap is close to the notch (the red dots). Use shims or wedges.
- 2) Measure the actual height of each gap, close to notches (the red dots). Yes, they all got the same underscribe amount, but each notch has compressed a little differently.
- 3) Add the gaps to get the total amount of gaps—Total Gaps (TG).
- 4) Find the widest gap under the *ends* of the long log (see *Figure 10*, the areas marked "A"). Set a scribe so the groove will be about 3" (75mm) wide at the widest spot (this is our normal process). Do not scribe anything yet. This is our *initial* setting.
- 5) Now, enlarge that initial scribe setting by the TG, and test this adjusted setting to see if it will work for middle portion of wall, over the island. This adjusted scribe setting (initial scribe setting plus TG) will *either*:
 - a) Produce a groove that is more than 3" (75mm) everywhere above the island. In that case, scribe the island's long groove with the adjusted setting (initial setting + TG). Then reduce the scribe-setting back down to the initial setting and scribe both end-portions (one-notch pieces) of the long groove.
 - OR . . . if the adjusted scribe-setting
 - b) would make a groove that is less than 3" (75mm) wide, or even fall through in the island area, then increase the scribe setting to get a 3" wide (75mm) groove in the island portion of the wall. Scribe the island portion with this increased scribe-setting. Then, reduce this scribe-setting by the TG and scribe the one-notch portions of the long groove (marked "A" in *Figure 10*).
- 6) Notch scribe settings will equal the scribe-setting that you used for the "A-portions" of the long grooves, minus your underscribe amount.

Figure 9: The shrink-to-fit, or Beckedorf "butterfly" notch. The saddle, instead of being flat or slightly concave, is convex—that is, the saddle is **higher** in the center.



Shrink-fit Notches

The other method that has been tried to keep notches tight over time has been to change the shape of the saddle—creating a high spot near its center. In *Figure 9* you can see the saddles are not like the standard concave saddles that appear throughout this book.

Shrink-Fit notches were invented by Lloyd Beckedorf, and he sometimes calls it the *butterfly* notch—the *Beckedorf Butterfly*. It has not been as widely adopted by professional builders as underscribing has been. My own experiences with it have shown me that with my logs, in my climate, and using my building techniques, underscribing is more effective for me than shrink-to-fit notches. The log home that I live in has shrink-fit notches, and was not underscribed (I built it in 1988). The shrinkage I got in log diameter has not seemed to bring the logs back to a fat-enough part of the saddle to keep the notches tight over time.

Lloyd specializes in using really big logs, and that probably helps explain why his butterfly saddle notch works better for him than it does for me. First, it's easier for him to create a serious rise in the middle of the saddle with huge logs. There's just a lot more wood to work with. Second, log diameter has a huge influence on the amount of log shrinkage. A 30" diameter (76cm) Douglas fir log will shrink *twice* as much in diameter as a 15" (38cm) Douglas fir log. So, big logs will shrink back farther, and get to a much thicker portion of the shrink-fit saddles that they sit on. This is why butterfly saddles work better for Beckedorf than for me.