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 scriber 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 that logs can shrink substantially in diameter, but hardly shrink at all in length.

And then, 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, but as logs dry, shrink, check, then the notches get loose. Loose notches allow the logs to twist, and gaps 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 has been to make the notches extra-tight at first, knowing that the corner notches will be shrinking, and this is called underscribing.
Underscribing Keeps Corners Tight

Starting in 1982, Del Radomske, a log home builder in British Columbia, began experimenting with ways to keep corner notches tight over time. He knew that 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 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 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.

**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 scribes 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 ⅛” (3mm) gap in the grooves. By the time he had two rounds on the building, he reported, the ⅛” 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 ¼” of overscribing was not enough to keep the notches tight over time (4 or 5 years). Del built another house with ¼” (6mm) underscribe, and watched it for years. Then he tried ⅜” (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).
How Much to Underscribe

The amount of underscribe you should use depends on: 1) the diameter of the logs you use; 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. We 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 am 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 all the notches in a building. I am now using just one underscribe amount for all the 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 ovendry 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 ovendry)—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). But, 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%), 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 ¼” of diameter (in metric: a 51cm white pine will shrink about 7mm). Because I want the corner notches to be tight, and compress slightly into the saddles after shrinkage is done, I’d use ⅜” (9mm) to underscribe all the notches of this building.

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 the old 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!
The logs that I 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 ¼" (18mm) of underscribe, but, I had been giving the sill logs of my buildings half this amount, ¼" (9mm) of underscribe (Figure 6.a). Over time, by observing my buildings as they dried, I realized that the sill logs should get a much smaller underscribe amount than the other wall logs. I didn’t know why, I just knew that ¼" (18mm) was way too much for my sill logs.

It turns out that ¼" is actually too much for all the notches, not just too much for the sill logs. And ¼" (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 ¼" (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% or greater).

Climate (ie, EMC) also affects drying and the underscribe amounts. A log home in a damp, coastal climate requires less underscribing than a log home built in a desert.

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 an estimate, 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 not underscribed.

For one-notch logs, one effective technique is to scribe small tabs at the end, or ends, that have no notch. 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, and the tabs are sometimes 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 conveyer 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.

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 logs 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 scriber that marks both the top and the bottom scribe lines, not a scriber 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 when 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 Not Changed

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.
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 (760mm) Douglas fir log will shrink *twice* as much in diameter as a 15” (380mm) 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, and the shrink-fit notches to stay tighter.