2000 LOG BUILDING STANDARDS

For Residential, Handcrafted, Interlocking, Scribe-fit Construction

The International Log Builders Association, founded in 1974 as the Canadian log Builders Association, is a world-wide organization devoted to furthering the craft of log construction. The ILBA is a registered non-profit Society in Canada and the United States. The ILBA writes and distributes educational material on log construction to individuals, institutions, and the industry. The organization is dedicated to the advancement of Log Builders and to promoting the highest standards of the trade.

It is the responsibility of every builder to understand and to conform to the best practices of the trade. These are minimum Standards for residential, hand-crafted, interlocking, scribe fit log construction. Log Building Standards are revised by the ILBA Building Standards Committee. Changes to this edition were made in January, 2000.

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2000 Log Building Standards

Preface

1. In these Standards the word "shall" means mandatory, and the word "may" means discretionary.
2. The 2000 Log Building Standards are comprised of both the Standards and the Commentary.

Section 1 FOUNDATIONS

Shall conform to applicable building codes and accepted engineering practice.

Section 2 LOG WALLS

2.A. Log Specifications

2.A.1. The minimum diameter of wall logs shall be 20 centimeters (8 inches).

2.A.2. Green or dry logs may be used for construction.

2.A.3. Logs shall have all bark removed.

	RIGHT HAND	LEFT HAND
straight	less than 1:20	less than 1:30
moderate	1:20 to 1:10	1:30 to 1:20
severe	greater than 1:10	greater than 1:20

Table 2.A

2.A.4. Spiral Grain

The following restrictions apply to the use of green logs. (Refer to Table 2.A for definitions of spiral grain categories):

a. Left-hand severe spiral grain logs shall be used as wall logs only as cut-in-half sill logs. However, left-hand severe spiral logs may be used as a whole-sill log if all four of the conditions listed below are also met.

b. Left-hand moderate spiral grain logs shall be used only in the lowest one-third (1/3) of the vertical height of a wall. However, moderate left-hand spiral logs may be used in the lowest one-half (1/2) of the vertical height of a wall if all four of the conditions listed below are also met.

c. Right-hand severe spiral grain logs shall be used only in the lower one-quarter (1/4) of the vertical height of a wall. However, right-hand severe spiral logs may be used in the lowest one-third (1/3) of the vertical height of a wall if all four of the conditions listed below are also met.

Conditions:

1) the log has two or more corner notches, *and*

2) the log is not spliced, *and*

Section 1 FOUNDATIONS

Like all buildings, the foundation of a log building must be of sufficient design to support safely the loads imposed as determined from the character of the soil. In addition to the loads imposed by gravity, the foundation is important in connecting the building to the ground as it resists wind or seismic forces and accelerations. Therefore the connection between the building and the foundation must also be capable of resisting the sliding, uplift and overturning associated with local wind and seismic conditions.

Section 2 LOG WALLS

2.A. Log Specifications

2.A.1. Logs smaller than 20 centimeters (8 inches) in diameter are unsuited to residential construction.

2.A.2. For the purposes of this Standard, "dry" means moisture content equal to or less than 19%, and "green" means moisture content greater than 19%. Dry and green logs have different requirements for preventing sapstain, and have different shrinkage and structural properties that must be appropriately accounted for in design and construction.

2.A.3. Leaving the bark on logs promotes insect attack and makes scribe-fitting difficult. Eventually, the bark will fall off by itself, though by that time the wood has usually been degraded by fungus or insects, or both.

2.A.4. Spiral grain is the condition in which the alignment of wood fibers is at an oblique angle to the long axis of the log. Spiral grain is expressed as the slope of the direction of fiber alignment to the length of the log- this slope is shown in Figure 2.A.

To determine fiber alignment, examine the log for surface checks caused by drying-surface checks are parallel to fiber alignment. Another option is to use a sharply pointed timber-scribe instrument designed for detecting spiral grain.

To determine whether a log has left-hand or right-hand spiral grain, place your right hand on the log, fingers pointing down the length of the log. You can stand at either end of the log. If the grain spirals around the trunk like a barber pole in the direction your thumb is pointing, then the tree has left-hand spiral grain. If the grain spirals in the direction your little finger is pointing, then the tree has right-hand spiral grain.

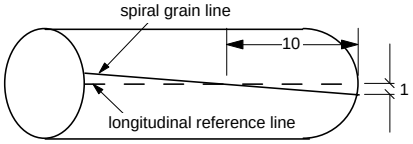
Scientific studies have shown that left-hand spiral grain logs undergo more severe distortions during drying than right-hand spiral grain logs, and this is one reason why greater restrictions are placed on the use of left-hand spiral logs (Table 2.A). Also, left-hand spiral grain logs are considerably weaker in bending and deflect more than straight-grain or right-hand spiral grain logs, though this is more critical in using logs as structural elements (joists, rafters, and timber members for example), than as wall logs.

3) no more than two-thirds (2/3) of the log's diameter is cut or removed at any opening, *and*
4) if any portion of this log extends beyond a notch in a wall, then the length of this extension is not more than 4'-0" (122 cm), measured from the center of the closest notch to the end-cut of this log.

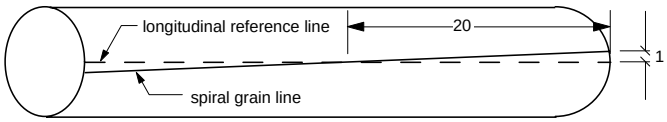
d. Right-hand moderate spiral grain logs may be used as a wall log at any location in the building, except shall not be used in the top round of wall logs.

e. Straight grain logs may be used in any location.

f. The top round of logs shall be straight grain only, see also Section 2.I.4.



EXAMPLE OF RIGHT-HAND SPIRAL 1:10



EXAMPLE OF LEFT-HAND SPIRAL 1:20

Figure 2.A

2.B. Log Walls

Shall be constructed of logs laid in horizontal courses, scribe-fit one to another, with interlocking notches at the corners.

2.C. Sill Logs

2.C.1. Shall be not less than 20 centimeters (8 inches) in diameter.

2.C.2. Shall be flattened on their bottom side for their entire length to a width of not less than 10.2 centimeters (4 inches).

2.C.3. Shall not be in direct contact with masonry.

2.C.4. Shall be set on a vapor, weather, and air barrier.

2.C.5. Shall have a drip cut or flashing that directs water away from the underside of the sill log.

2.C.6. Shall be anchored to resist applicable wind and seismic loads.

2.C.7. Shall be a minimum of 30.5 centimeters (12 inches) above grade.

2.D. Long Grooves

2.D.1. Logs in walls shall have a continuous scribe-fit long groove along the length of each log. A long groove is required wherever a log wall separates unheated from heated space, or heated space from the exterior of the building.

Section 2.A.4 describes the ways builders can help hold spiral logs in place in the walls. Logs that are more likely to twist are used lower in the wall, where there is more weight on them. For spiral types (a), (b), and (c) the standards can be relaxed somewhat if you use four additional methods to restrict twisting. A log that has at least two full notches is more likely to stay put than a log with one notch (Condition # 1). A full notch is more stabilizing than a spliced notch (Condition # 2). A spiral log with a window sill cut-out will not behave like it is one piece if more than two-thirds of a log's diameter is removed (Condition # 3). And, when a wall log extends beyond a notch more than 48 inches (122 centimeters) to a door or window opening, this portion of the log is more likely to twist (Condition # 4).

Table 2.A refers to green logs, slope of grain may change as logs dry.

2.B. Log Walls

These Standards do not apply to walls constructed of vertical logs, or logs that are not fully scribe-fit to one another (e.g. chinked), or to Piece en Piece, or to manufactured log home kits. For more on notches see Section 4.

2.C Sill Logs

2.C. Sill Logs are the bottom logs of the building, the first logs above the foundation in each wall.

2.C.1. See also the log specifications in Section 2.A.

2.C.2. A continuous sawn flat provides bearing area and stability for sill logs.

2.C.3. Untreated wood should not be in direct contact with masonry because of the likelihood of decay.

2.C.4. Caulks, sealants and gaskets can provide vapor, air and water barriers.

2.C.5. To avoid decay, it is important that rainwater be directed away from under the sill logs.

2.C.6. The amount and kind of anchoring depends upon local conditions and codes. In areas of extreme wind and seismic load conditions, continuous through-bolting the full height of the log wall to the foundation can be an effective technique.

2.C.7. Sill logs can be prone to decay if they are too close to grade and rainwater and soil splashes on them.

2.D. Long Grooves.

Also known as "lateral," "lateral groove," "cope," "Swedish cope," and "long notch." The long groove is a notch cut into a log to fit two logs together along their length and between intersecting corner notches.

2.D.1. The long groove must be continuous between notches, or between openings, such as doors. Other styles of log construction do not have a long groove, or have a groove that is not continuous—the gaps between logs are then filled with a chinking material. Scribe-fit logwork, in contrast, has a continuous long groove, and no chinking is required because there are no gaps to fill. The interior edges of the long groove are often sealed with a gasket material, and the interior cope is commonly insulated.

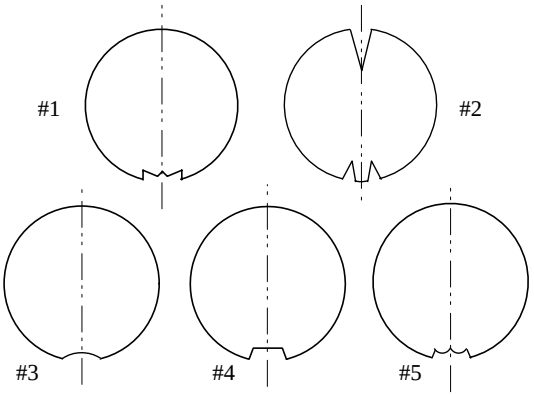


Figure 2.D

2.D.2. Long grooves shall be self-draining or shall have gaskets, and in all cases shall restrict water, air, and insect infiltration

2.D.3. The minimum width of the long groove shall be 6.3 centimeters (2.5 inches) and this minimum width shall extend for no more than 30.5 centimeters (12 inches) in continuous length. At all times, however, the long groove shall conceal and protect through-bolts, pins, dowels, kerfs, electrical holes, and the like, and shall be wide enough to restrict weather and insect infiltration.

2.D.4. The maximum width of the long groove shall be three-eighths (3/8) of the log diameter at each point along the log. In cases of extremely irregular log contours the width may be increased to one-half (1/2) of the log diameter, but this increased allowance shall extend for no more than 46 centimeters (18 inches) in continuous length.

2.D.5. The long groove may have the following cross-sectional profiles: rectangular, shallow cove, "W" shaped, or double-scribed.

2.D.6. The depth to which the groove is cut shall be less than one-quarter (1/4) the diameter of the log (see also Section 2.J.2).

2.E. Log Extensions

2.E.1. The maximum length of log extensions shall be based on weather protection criteria described in Section 7.D.

2.E.2. The minimum length of log extensions shall be 23 centimeters (9 inches) measured from the edge of the notch to the end of the log overhang. This standard applies to both interior and exterior log extensions. Dovetail corner notches are exempt from this requirement.

2.E.3. Exterior log extensions shall not have a tight fit to the log extensions below. See Figure 3.B.3

2.D.2. Some profiles are not self-draining, that is they could trap water, and so promote decay. Such long grooves shall have gaskets to restrict water from getting into the groove. Being visibly tight is not sufficient to restrict air or water infiltration.

2.D.3. Narrow long grooves are difficult to seal from the weather. The groove must always be wide enough to restrict weather infiltration into kerfs, electrical holes, and the like.

2.D.4. Wide long grooves remove so much wood that the log is unduly weakened and may check only on the bottom of the log, which is not desired. (See also Section 2.J.)

2.D.5. There are many shapes, or cross-sectional profiles, for long grooves. Figure 2.D illustrates some of these. Desired traits are: sharp and strong edges along the scribe line; a reasonable minimum amount of wood removed from the groove so that the groove touches the log below only along its scribed edges with no internal "hang-ups;" and a reasonable assurance that the log will check on its top (that is, in the kerf) as it dries. (See Section 2.J for more on kerfs.)

2.D.6. Deep long grooves are not necessary, and can weaken a log. Note that at least one-half of the diameter of the log must remain intact after both the kerf and long groove are cut (Section 2.J.2).

2.E. Log Extensions *Also known as "flyways" or "log overhangs," are the short part of the log that extends past a notched corner.*

2.E.1. Overly long log extensions can be prone to decay unless adequately protected by roof overhangs, or by other means.

2.E.2. Overly short log extensions can be prone to having wood split off, severely weakening the notch and the corner. Interior log extensions are those that project inside a building, and exterior log extensions extend towards the outside of a building. The stability of a dovetail corner does not depend upon log extensions, and is not susceptible to having wood split off, and so is exempt from any minimum length requirement.

2.E.3. The end-grain of exterior log extensions can take on moisture seasonally, shrinking or swelling more than the rest of the log. If the long grooves of extensions fit tightly, then during periods of high moisture the tight fit of the long grooves along the rest of the log could be compromised. This has, in fact, been observed—tight long grooves in the log extensions and gaps in the grooves everywhere else.

Since log extensions are not kerfed (Section 2.J.7), it is probable that log extensions will check on their bottoms—from their long grooves towards the center of the log. When logs check in this location, internal hang-ups are common. To avoid this, the grooves of exterior log extensions should have enough wood removed to avoid hang-ups after checking and slumping. See Figure 3.B.3.

2.E.4. Where a log extension acts as a support for a structural member this extension and the structurally supporting logs shall be exempt from the requirement in 2.E.3 (see also Section 7.J).

2.F. Distance Between Corners

2.F.1. When using logs with a diameter less than 30.5 centimeters (12 inches) the distance between intersecting log walls with corner notches shall be no more than 7.3 meters (24 feet). When using logs with a minimum diameter of 30.5 centimeters (12 inches) the distance between corner notches shall be no more than 9.75 meters (32 feet). Log walls with spans in excess of these distances shall have reinforcement such as wood keys, dowels, smooth-shaft steel, through-bolts, lag screws, steel bar, or log stub-walls. All such reinforcement shall allow for settling (see Section 6).

2.F.2. Log walls with openings cut for doors, windows and passageways may require additional bracing. The loads on a log wall, and the openings cut into a log wall, will affect its structural performance and may require structural analysis.

2.G. Joining Logs Lengthwise

2.G.1. Spliced logs shall be secured to each other with bolts or other fasteners, and to adjoining courses of logs above and below with steel pins, wooden dowels, lag bolts or through-bolts in a manner that preserves the structural integrity of the wall.

2.G.2. When more than half of the logs in a corner are spliced, then engineering analysis shall be required.

2.G.3. The notch and long-groove shall at all times completely hide a splice and its fasteners, and help protect splices against weather and insect infiltration.

2.H. Header Logs

2.H.1. A header log shall have no more than half of its vertical height removed at the location of openings, unless it is covered by at least one more log. In all cases, the header log shall be adequate for structural requirements.

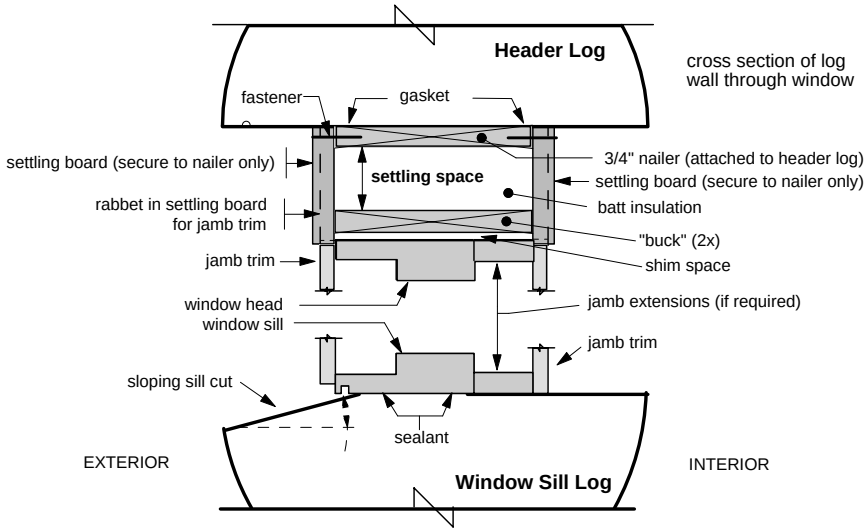


Figure 2.H.1

2.E.4 Where roof overhangs, outriggers, or balconies are supported by log extensions, it may be necessary to have two or even three log extensions fit tightly so as to gain the structural strength needed to support the cantilevered load put on these logs.

2.F. Distance Between Corners

2.F.1. Log walls gain lateral stability from corner notches at stub walls and intersecting log walls, and this is the reason for limiting the distance between notched corners. Larger logs are laterally more stable than small logs and so are allowed a longer maximum distance between notches.

2.F.2. Openings cut into a log wall, especially numerous, tall, or wide openings reduce the lateral stability of the wall. Some stability is gained by door and window framing (see Section 5), but in most cases other steps must be taken to stabilize the wall, especially when the wall is supporting the load of floors or roofs.

2.G. Joining Logs Lengthwise

2.G.1. Some walls are straight and too long to be spanned with single logs, and so logs are joined end-to-end. Better design may be to step a long wall in or out to add corner notches and allow the use of wall-length logs, thereby eliminating end-to-end splices. End-to-end butt splicing of wall logs is an acceptable practice, however, so long as steps are taken to maintain the strength and stability of the walls and corners, and the spliced joint is completely covered from view.

2.G.3. The completed wall must appear to be made of only continuous, full-length logs. No exposed splices or joints are allowed. All joints and splices must be completely covered by corner notches or stub-wall notches.

***2.H. Header Logs** are logs at the head, or top, of window and door openings cut into log walls.*

2.H.1. A header log has a level, sawn cut facing the opening. A header cut should not remove more than half the vertical diameter of the header log at this point unless the strength of the wall is sufficient to support the roof and floor loads placed upon it.

2.H.2. Openings in header logs shall be cut so as to completely cover door and window head jambs and exterior trim in order to restrict water infiltration.

2.I. Plate Logs

2.I.1. Wall plate logs shall be notched, drifted, pegged, lag-bolted or through-bolted to the log below to prevent movement caused by drying stress and roof thrust. Wall plate logs shall be attached with lag or through-bolts to one or more rounds of logs below the plate log so as to resist the uplift forces associated with local wind and seismic conditions.

2.I.2. Where conventional framing meets a plate log this intersection shall have an expandable gasket to accommodate anticipated shrinkage of the log plate and to restrict weather and insect infiltration.

2.I.3. The ceiling vapor retarder, where required by local code, shall be permanently sealed to the plate log with caulk or sealant.

2.I.4. Plate logs shall be straight grained wood (see Section 2.A.4.f).

2.J. Kerfing

2.J.1. When building with green logs, a longitudinal kerf shall be cut on the top of each wall log.

2.J.2. The depth of the kerf shall be at least one-quarter (1/4) of the diameter of the log, and shall be no deeper than one-half (1/2) the diameter. In no case shall more than one-half (1/2) the diameter of the log be removed by the kerf and long groove combined.

2.J.3. Kerfs shall at all times be protected from weather by being fully covered by the long groove of the log above, or by a notch.

2.J.4. The kerf shall be continuous, or shall start 15 centimeters (6 inches) from the edge of all notches, and shall be continuous between the notches, except that kerfs need not extend into openings in log walls, or at the ends of log extensions, where they would be seen.

2.H.2. Figure 2.H.1 illustrates one way to install settling boards and avoid water infiltration.

***2.I. Plate Logs** are the top logs on each wall. The roof framing rests on the plate logs.*

2.I.1. Wall plate logs are prone to twisting and shifting and need extra steps to keep them in place. Square notches and lock notches can provide restraint, as can any number of methods using bolts, threaded rod, and pegs. The number, type, size, and spacing of mechanical fasteners used for this purpose must be determined by accepted engineering practice. Continuous gable-end plate logs are very effective at resisting roof thrust, and so are recommended when it is necessary to counteract these forces. When continuous gable-end plate logs are not used, or are not used in a manner that will resist roof thrust, then this force must be restrained or eliminated by other methods.

Roof uplift caused by wind, for example, can be counteracted by locking together the top rounds of each wall. Smooth pins such as dowels, smooth shaft steel, and wooden pegs are not sufficient for preventing uplift, and this is why lag bolts and through-bolts are specifically mentioned.

2.I.2-3. A study of Minnesota log homes found the intersection of roof framing and the plate log to be the source of considerable air infiltration. Special steps are required to make this area weather-tight. Permanently sealing the vapor barrier to the plate log is an accepted method of reducing air infiltration and retarding the migration of water vapor. Stapling the vapor retarder to the plate log is, by itself, not sufficient.

2.J. Kerfing

2.J.1. The kerf is usually, though not always, a cut made with a chainsaw. Logs are known to check, or crack, in those places where wood has been removed closest to the pith, or center, of the log. Kerfing is therefore an effective way to control the location of checks as green logs dry.

Because dry logs already have seasoning checks, kerfing will not change the location of checks, and therefore kerfing usually is not required for dry logs.

2.J.2. The kerf must be deep enough to promote checking. Note that even those long groove profiles that do not require kerfing (like the double-cut) are nevertheless required to be the depth of at least one-quarter of the diameter of the log at every point along the top of the log. (See also Section 2.D.5.)

After a log has both the kerf and the long groove cut, there must still be at least one-half of the diameter of the log remaining un-cut. Removing more than half the diameter of the log for kerf and groove combined would weaken the log, and so should be avoided.

The amount of wood removed by the kerf (or special long groove profile) must be between 1/4 and 1/2 of the log diameter (Section 2.D.6). When the kerf is 1/4 of the diameter of the log deep, then the groove must be no more than 1/4 of the log diameter deep (1/4 plus 1/4 equals 1/2). When the kerf is 1/3 of the log diameter deep, then the groove must be no more than 1/6 of the log diameter deep (1/6 plus 1/3 equals 1/2).

2.J.3. Because kerfs are not self-draining, that is, they can catch rainwater and hold it, kerfs must always be protected by being fully covered by the groove of the log above (also see Section 2.D.3). In practical terms, this means that kerfs are never visible in a completed wall.

2.J.5. No kerf shall be required when the long-groove profile encourages checking on the top of wall logs as in Figure 2.D #2, as long as the groove and kerf along the top of the log is at least 1/4 of the diameter of the log.

2.J.6. No kerf shall be required on the top of the half-log sill logs.

2.J.7. No kerf shall be cut in exterior log extensions.

2.K. Log Wall-Frame Wall Intersections

2.K.1. Log walls shall be cut as little as necessary when joined to non-log partition walls.

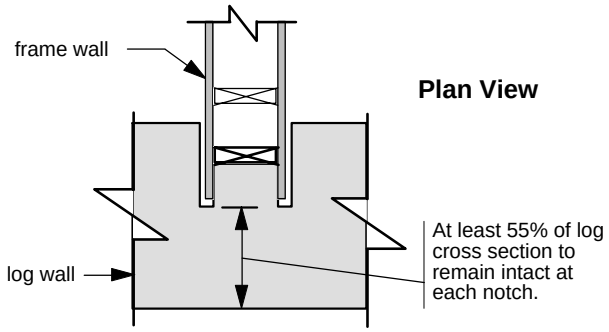


Figure 2.K.1

2.K.2. Where wood is removed at the intersection of a log wall and frame wall, the log wall shall have 55% or more of its cross-sectional area remain intact and uncut. See Figure 2.K.2.

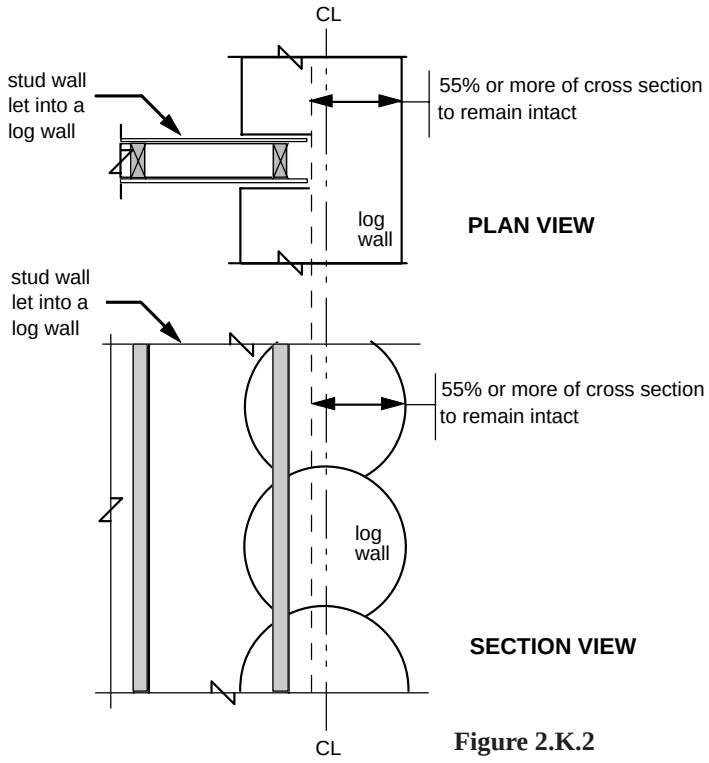


Figure 2.K.2

2.J.4. The kerf should run the full length of the top of every log, either stopping before reaching a notch, or continuing through a notch. In the case of openings or passageways cut in log walls that are not covered by jambs or doors, the kerf would be unsightly—and in these areas the kerf need not extend all the way to the opening.

2.J.5. Some long-groove profiles encourage checking without kerfing. For example, the long-groove known as double-cut or double-scribed (see Section 2.D.5), removes a "V" shaped section from the top of every log. Long-groove profiles that promote checking on top of wall logs do not require a kerf, but they must comply with Section 2.J.2.

2.J.6. Half-logs do not usually check, and so do not require a kerf.

2.J.7. No kerf should be cut on any log extensions outside the building because this upward-facing cut could catch and hold moisture from rain and promote decay. The long grooves of exterior log extensions shall not be tight-fitting (Section 2.E.3), and so do not protect the kerf from water, and this is why log extensions should not be kerfed.

2.K. Log Wall-Frame Wall Intersections

It is common for some interior, non-bearing partition walls to be conventionally framed with studs. This section describes how stud walls and other non-log walls should be attached to logs walls.

2.K.1. It is common for a plumb groove, dado, or rabbet to be cut in the log wall and the first stud of the frame wall to be attached to the log wall in this groove. One problem is that to have the frame wall completely seal against the log wall, the groove must be cut as deep as the narrowest long groove, and this is often close to the mid-point of the log wall. One way to avoid removing too much wood from the log wall, and unduly weakening it, is shown in Figure 2.K.1.

2.K.2. Enough wood must be left in the log wall that it is not weakened by the dado. The dado must leave 55% or more of the cross-sectional area at this intersection uncut, Figure 2.K.1.

2.K.3. Where frame partition walls are notched into opposite sides of a log wall there shall be a minimum of 122 centimeters (4 feet) between the end of one notch and the beginning of the next notch on the opposite side of the log wall, or, if closer than 122 centimeters (4 feet), a minimum of one-third (1/3) of the wall cross-sectional area shall remain intact and uncut.

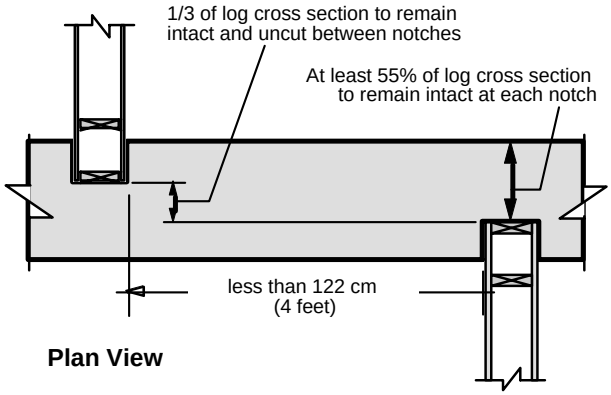


Figure 2.K.3

2.K.4. In no case shall cuts go past the centerline or midpoint of the log wall.

2.K.5. Log wall-frame wall intersections must allow for unrestricted settling of the log wall (see also Section 6).

2.L. Height of Log Walls

Log walls taller than two stories, or 6.1 meters (20 feet) in height, shall require engineering analysis.

2.M. Bearing Walls

Bearing walls shall be designed and constructed to structurally accommodate horizontal and vertical forces which are anticipated to act upon the building.

2.N. Preservation of Log Walls

Where necessary, steps should be taken to restrict the growth of mildew and fungus on logs while the building is under construction.

Section 3 NOTCHES

3.A. Self-Draining and Weather-Restricting Notching

All forms of interlocking notches and joinery shall be self-draining and shall restrict weather and insect infiltration.

3.B. Notching Standards

3.B.1. Notches shall have a concave profile across the notch not less than 1.5 centimeters (5/8 of an inch) and not more than 3.5 centimeters (1 and 3/8 inches).

2.K.3. Where two frame walls are closer than 122 centimeters (4 feet) to each other, and on opposite sides of a log wall, the cross section of the log wall, after both dadoes are cut, must have at least one-third of the wall area remain un-cut, Figure 2.K.3 Note, also, that Section 2.K.1 still applies—each single cut shall leave 55% or more of the cross sectional area at each intersection un-cut and intact. See Figure 2.K.3.

2.K.4. Cutting past the center of a log wall weakens it, and should be avoided.

2.K.5. The first stud attached to the log wall must be fastened in such a way as to allow the log wall to shrink and settle. One common method is for lag screws to be attached to the logs through vertical slots cut in the stud, not just round holes. The lag screw and washer should be attached near the top of the slot, and allowed to slide down the slot as the log wall behind shrinks in height.

The frame wall must also allow a second floor, or the first floor ceiling, to lose elevation as the log walls shrink in height. (See Section 6 for more on settling.)

***2.L. Tall log walls** should be evaluated for stability.*

2.M. Bearing Walls

Bearing walls can be exterior or interior log walls. Roof and floor loads are the most common loads to design for, but uplift and lateral loads from winds and seismic activity may have to be considered as well.

2.N. Preservation of Log Walls

Green logs, in particular, are prone to attack by mold, mildew, and fungus during construction. Dry wood will not decay, and so good roof protection is very effective in prolonging the life of log walls. During construction, and until roof protection is complete, it may be advisable to use sapstain and mold preventative chemicals or processes. Additionally, the use of a sealant on all exposed end grain during log storage, construction and after all work is completed will slow the loss of moisture and reduce checking.

Section 3 NOTCHES

***3.A. Self-draining** means that notch surfaces slope in a way that restrict water from getting into areas where it can be held, promoting decay. Interlocking means that notches will tend to be stable when exposed to stresses and loads that the corner can reasonably be anticipated to experience. Shrink-fit and compression-fit notches are designed to remain tight fitting as the wall logs shrink in size as they dry. (Note that a round notch which is designed to function as a compression-fit notch also meets this criteria.)*

3.B Notching Standards

3.B.1. When a straightedge is held across a notch so that it is approximately perpendicular to the long axis of the log and so that the straightedge touches the scribed edges of the notch, then the straightedge should not touch the inside of the notch at any place. In fact, the gap between the straightedge and the inside of the notch should be between 1.5 and 3.5 cm (5/8" and 1-3/8").

3.B.2. Notches shall be clean in appearance and have no ragged edges.

3.B.3. To maintain tight notches with green logs the following apply:

a. Space shall be left at the top of the notch to allow for compression.

b. Sapwood from the sides of the log should be removed to create a saddle scarf. These saddle scarfs shall be smoothly finished.

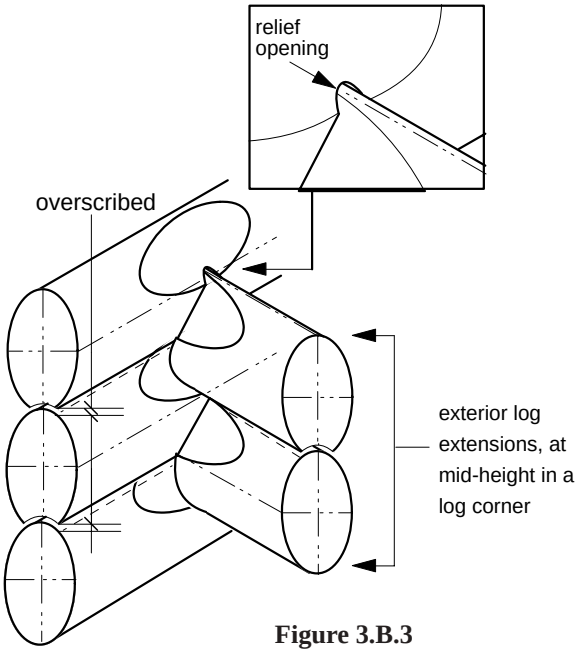


Figure 3.B.3

3.B.4. The amount of log to remain uncut at a notch shall not be less than one-third (1/3) the original diameter of the log, or not less than one-third (1/3) of the original cross-sectional area.

3.B.5. All forms of dovetail notches are exempt from the requirements of Section 3.B.

3.C. Blind Notches

A blind-notch shall resist the separation of the two log members it joins, or shall have mechanical fasteners that resist separation.

Section 4 JOISTS AND BEAMS

4.A. Joists and beams, if dimensional material, shall conform to applicable building codes.

4.B. Joists and beams, if log or timber, shall conform to the following standards:

4.B.1. Shall have straight grain, or shall be right-hand spiral grain, with spiral no more than 1:12. (See Section 2.A.4 for more on spiral grain.)

This means that the notch, when in place over the log below, should touch the log below only on its scribed edges, and should touch at no other place. (If it touches on some inside place it causes a "hang up.") The concave area created by scooping out the notch in this way not only prevents internal hang-ups, but also can be used to place materials that will prevent air infiltration through the notch (gaskets and insulation, for example)—an important consideration in all climates.

3.B.2. The scribed edge of notches should be sharp, strong, and cleanly cut. The edges should not crush or permanently deform under the load they support. Ragged wood fibers may indicate weak notch edges or a notch that was cut past the scribe line.

3.B.3. There are techniques that help keep notches tight as green logs season and dry. One technique is to remove wood at the top of a notch to allow the notch to compress onto the log below as it dries. The extra wood removed from the top of a notch creates a gap that should be nearly invisible when the corner is assembled, that is, the gap should be covered by the notch of the next log. Figure 3.B.3.

Cutting saddles, or saddle scarfs, is another technique that helps. Saddle scarfs should not be simply chainsawed off, but should be finished to a smoother surface. See Figure 3.B.3.

3.B.4. After a notch has been cut there shall be no less than one third of the log's original cross-sectional area or diameter at the notch remaining uncut.

Removing more than two-thirds of the log area or diameter by notching weakens a log, sometimes even to the point where the log extensions may break off. Good log selection avoids the problem of notches that remove more than two-thirds the diameter of the log at the notch.

3.B.5. Dovetail notches are unlike most other notches, and are not required to follow the standards of Section 3.B.

3.C. Blind Notches

A blind notch is a log joint in which one log does not cross over or beyond the other log. Because one log does not continue past or over, it can be prone to separating from the log it is joined to. To resist separation the following methods are recommended:

1. *A dovetail or half-dovetail on the blind notch to interlock with the intersecting log.*
2. *Hidden dowels that accommodate settling.*
3. *Hidden metal straps, fasteners or bolts to join the intersecting log walls together.*

Section 4 JOISTS AND BEAMS

4.A. Dimensional joists and beams (including rafters, purlins, ridges, and the like) shall conform to local applicable building codes for dimensions, load, and span.

4.B. Log joists and beams, including sawn timber members, shall be sized to adequately support the loads they carry.

4.B.1. Studies have shown that left-hand spiral grain logs and timbers are significantly weaker than straight and right-hand grain members, but it is not yet known precisely how much weaker. Therefore, left-hand grain is not allowed for these members unless it can be shown that it is structurally adequate. Straight-grain, and right-hand spiral grain up to a slope of 1:12, is allowed.

4.B.2. Shall be designed to resist all loads according to applicable building codes and accepted engineering practice.

4.C. Where log or timber beams are notched at an end, on the bottom face, the depth of the notch shall not exceed one-fourth (1/4) of the beam depth at the location of the notch, or less if calculations so indicate.

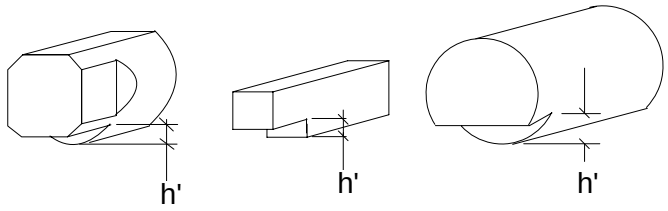


Figure 4.C

4.D. Where log or timber joists are supported by a log wall, the wall logs shall be notched to receive the joists in such a way as to prevent failure in the supporting log wall.

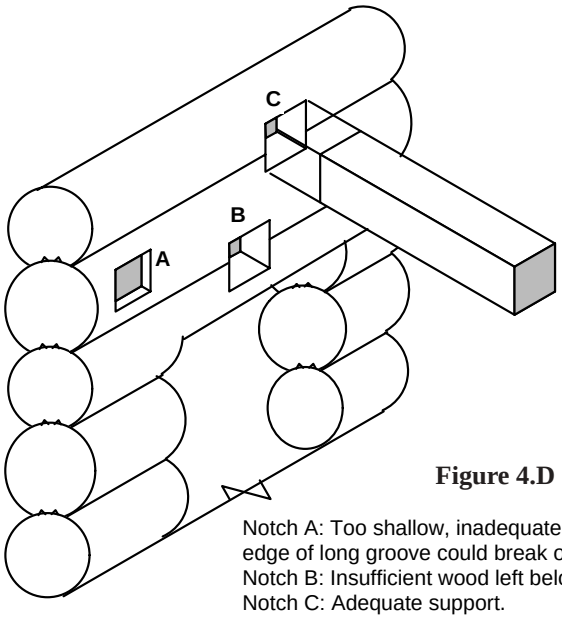
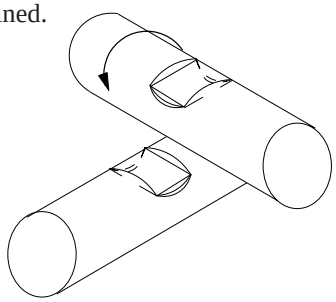


Figure 4.D

Notch A: Too shallow, inadequate bearing, edge of long groove could break out.
Notch B: Insufficient wood left below notch.
Notch C: Adequate support.

4.E. The distance, after settling is complete, from the bottom of ceiling joists and beams to the finished floor shall conform to applicable building codes.

4.F. Where a beam or joist passes through a wall to support additional floor areas or other loads, the beam or joist shall be notched in such a way that the structural integrity of both the beam and the supporting wall are maintained.



Square notch

Figure 4.F

4.B.2. At all times, log and timber beams and joists must be designed and installed to adequately resist the loads they will experience. Joists and beams with excessive deflection can cause uncomfortable, and in some cases, unsafe, springiness in floors and roofs. Long spans are prone to excessive deflection, and in some cases a deflection limit of 1/360 of the span may not be sufficient. It is prudent to consult with an engineer familiar with wood structures for assistance in the design of complex load carrying systems.

4.C. Where joists and beams are notched at their ends (for example, to be supported by a log wall), no more than one-quarter (1/4) of the height of the beam shall be removed from the bottom of the beam. Less than one-quarter (1/4) shall be removed if engineering calculations require. See Figure 4.C.

4.D. It is also important to not remove so much wood from a log wall that is supporting a beam or joist such that the log wall itself is unreasonably or unsafely weakened. One example would be a joist above a door or window opening, see Figure 4.D.

4.E. Joists and beams (whether log, timber, or dimensional material) that are supported by log walls will get closer to the floor as the logs dry and shrink and the log wall gets shorter in elevation. Many local building codes specify the minimum height from the floor to joists and beams above. The height of joists and beams off the floor must conform to local building codes, if any, after settling is complete. (See Section 6.A for more on calculating settling allowances.)

4.F. One common log building design has floor joists that cantilever through an exterior log wall to support a balcony or roof load outside the building. It is not uncommon for the stresses which this type of beam must withstand to be at a maximum where the beam passes through the log wall. It is therefore important that all such cantilevered beams not be substantially weakened due to notching at this location. A square notch is one way to help protect the strength of the beam, Figure 4.F. Square notching does remove more wood from the log wall than other notches, and so it is important to ensure that the wall is not weakened past its ability to support the loads placed upon it.

4.G. Where an interior beam extends through a wall to the exterior it shall be protected from the weather so that its structural integrity is maintained. The intersection of the beam and wall shall be constructed to restrict weather and insect infiltration. See also Sections 7.F and 7.G.

4.H. Log joists and beams shall be flattened on top to a minimum of 2.5 centimeters (1 inch) where they support flooring or framing.

Section 5 WINDOW AND DOOR OPENINGS

5.A. Settling space shall be provided for all doors and windows placed in walls constructed of horizontal logs.

5.B. The settling space for windows and doors shall be covered by a cladding or trim to restrict weather and insect infiltration. In order to not restrict settling and to avoid damage to windows or doors this covering shall not be attached to both the log wall and to the window or door frame until all settling is completed. A vapor barrier shall be installed within this space, on the heated side of the insulation.

5.C. Trim at jambs shall not restrict settling.

5.D. Both sides of each opening shall be keyed vertically to withstand lateral loads, and in such a way as to allow unrestricted settling.

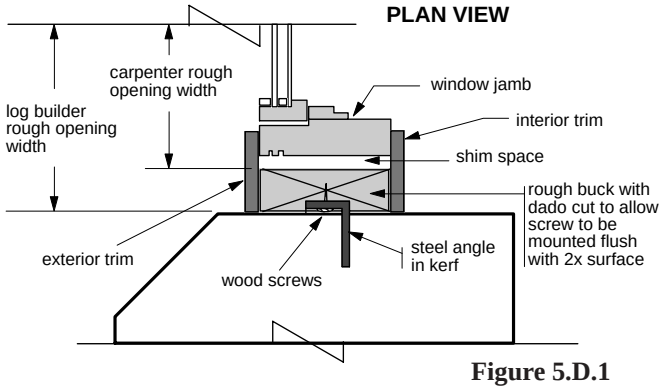


Figure 5.D.1

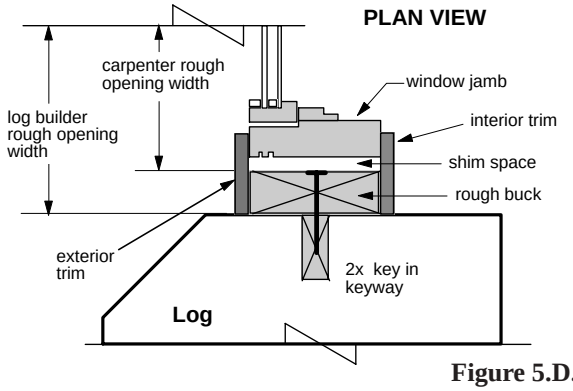


Figure 5.D.2

5.E. All exterior sills shall be beveled to allow water to drain to the outside face of the log wall.

4.G. Cantilevered log beams that extend outside the building (even if they are only notched through the wall and have relatively short log extensions) need protection from decay. Metal flashings, waterproof membranes and wide roof overhangs are recommended. The top of any deck supported by logs or other structural members must slope so that water will drain in a manner that protects the house from damage. This type of detailing is important because of the susceptibility of unprotected log-ends to decay, and the great difficulty and expense in repairing or replacing such logs once degradation occurs.

Section 5 WINDOW AND DOOR OPENINGS

5.A. Openings cut in log walls become shorter over time as the logs dry to an in-service condition. The settling space must not have any materials in it that does not allow for the space to become vertically shorter over time. (See also Section 6 for more about shrinkage and settling.)

5.B. Settling spaces are typically covered by settling boards, which are pieces of trim that are wide enough to span the settling space. The settling boards can be attached to the log or to the window or door framing, but not to both. Attaching the settling board to both would not allow for the settling space to get smaller over time, and would either cause the logs to hang up, or the windows or doors to deform.

5.C. The sides of doors and window trim must allow for logs to settle unhindered. This means that the jamb trim on the sides of doors and windows cannot be attached to the log wall. Side trim can be attached to the window or door and to bucks, see Section 5. D.

5.D. Openings in log walls for door and windows need special framing to install the jambs of doors or windows; and this framing is usually called a "buck." The bucks must allow for logs to shrink and settle-typically this means that the height of the bucks is less than the height of the log opening, and the difference in these heights is equal to, or greater than, the settling allowance. (See Section 6.A for help calculating settling allowances.) The bucks are usually attached to keys of wood or angle iron that are let into the log ends of openings. Keys are required because they hold the bucks in place and because they laterally stabilize the log wall at openings: they restrict logs from moving horizontally while still allowing logs to move vertically. See Figures 5.D.1 and 5.D.2 .

5.E. Where a log acts as an exposed exterior window or door sill, it must shed water and slope so that it drains away from the window or door.

5.F. The position of openings in walls constructed of horizontal logs shall conform to the following:

5.F.1. The distance from the side of window and door openings to the centerline of an intersecting log wall shall be a minimum of 25.4 centimeters (10 inches) plus one half the average log diameter.

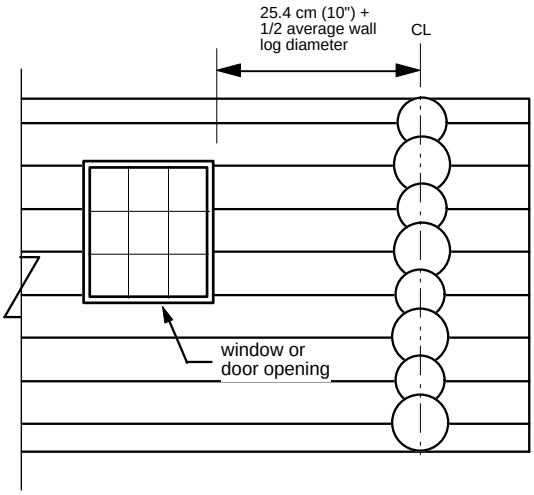


Figure 5.F.1

5.F.2. Wall sections between openings shall be a minimum of 92 centimeters (36 inches) long, or shall be provided with support in addition to the required keyways (see Section 5.D).

Section 6 SETTLING

6.A. Settling Allowance

6.A.1. The minimum allowance for settling when using green logs is 6% (3/4 inch per foot of log wall height).

6.A.2. The settling allowance for dry logs may be up to 6%, but may be less than this, depending upon the moisture content of the logs.

5.F. Window and Door Location

5.F.1. It is undesirable to have door and window openings cut too close to intersecting log wall and stub wall notches. The notched log is weakened and may split off if it is too short. (This situation is comparable to log extensions that are required to be a certain minimum length, see Section 2.E.2.) Therefore, window and door openings shall be cut no closer to the centerline of an intersecting log wall or log stub wall than 25.4 centimeters (10 inches) plus half the average log diameter, see Figure 5.F.1.

5.F.2. Sections of log shorter than 92 centimeters (36 inches) are prone to split, and are also unstable (since they do not contain a log corner), especially if they support loads such as those of a second floor or roof. Therefore, it is best if the sections of log wall between doors, between windows, and between a door and a window, be longer than 92 centimeters (36 inches). Sections of log wall can be shorter than this minimum if there is sufficient additional support used, but the keys required by Section 5.D do not qualify as additional support, unless they are part of a column-and-screwjack settling system.

Section 6 SETTLING

6.A. Settling is the term that describes the loss of log wall height over time. The principal causes of settling are:

*1) **shrinkage** of log diameter as logs dry to an in-service condition (also known as equilibrium moisture content, or EMC), and 2) **compression** of wood fibers under the load of the building. A third component is **slumping**, which occurs if logs check only in the long groove. Slumping is nearly eliminated by kerfing, which is one reason why kerfing is required, see Section 2.J.*

6.A.1. Green logs (defined in Section 2.A.2 as logs with greater than 19% moisture content) must be allowed to settle 6% (6 centimeters per meter, or 3/4 inch per foot) of wall height. Note that logs cannot be expected to shrink to equilibrium moisture content or completely settle by air-drying alone, but must be expected to complete settling only after a period of up to 5 years as part of a heated building. The time needed to reach equilibrium moisture content depends on a number of variables, including wood species, log diameter, initial moisture content, interior temperature and humidity, and climate.

In general, logs do not shrink much in length, and so only the loss of diameter must be considered for settling. With extremely long logs (more than 15 meters, or 50-feet), however, it is advisable to investigate the loss of length as they dry.

6.A.2. Dry logs (defined in Section 2.A.2 as logs with moisture content equal to, or less than, 19%) may settle nearly as much as green logs. In part, this is because of the nature of the definitions of dry and green—19% MC is a "dry" log and 20% MC is a "green" log, but these two logs will obviously differ very little in the amount they actually shrink in diameter as they approach EMC.

It must be assumed that log walls made of dry logs will settle. Further, it should be assumed that logs stored outside, not covered by a roof, are not at EMC, and will shrink. The amount of shrinkage depends upon the difference between the actual moisture content of the logs (as determined by a moisture meter, for example) and the final in-service EMC.

6.B. Adequate provisions shall be made for settling at all openings, load bearing posts, chimneys, fireplaces, interior frame partition walls, electrical entrance boxes and conduits, plumbing vents and drains, second story water and gas pipes, staircases, downspouts, heating and air conditioning ducts, and all other non-settling portions of the building.

6.C. The log contractor shall provide information to the general contractor to help guide subcontractors in the use of techniques applicable to their trade to deal with the unique characteristics of log construction, and specifically how each trade should accommodate for settling.

6.D. All caulking and weather-sealing must account for the change in diameter and shape of the logs as they dry.

Section 7 ROOFS AND ROOF SUPPORT SYSTEMS

7.A. If constructed of dimensional material, shall conform to applicable building codes.

7.B. If constructed of log or timber, roof systems shall conform to the following standards:

7.B.1. Shall be constructed only of straight-grain, or moderately right-hand spiral grain material (see Section 2.A.4 for definitions of spiral grain).

7.B.2. Shall be designed to resist loads according to applicable building codes and accepted engineering practice.

7.B.3. Where beams are notched at an end, on their bottom face, the depth of the notch shall not exceed one-fourth (1/4) the beam depth at the location of the notch, or less if calculations so indicate.

7.C. The distance from the bottom of roof beams to the finished floor must conform to applicable building codes after settling is complete.

7.D. Roof overhang shall help protect log walls from the weather associated with the site of the building. Figure 7.D illustrates how to calculate the minimum roof overhang.

Settling allowance for dry logs may be reduced from the required 6%, and the amount of the reduction allowed is proportional to the actual moisture content of the logs. Note, however, that even if the initial moisture content of the logs is equal to EMC, and the logs are not expected to shrink, the logs will still compress somewhat, and there must be a settling allowance for this compression.

6.B. Everything that is attached to a log wall must accommodate settling. Also, settling problems must be investigated even between two non-log items. For example, there is settling that must be accommodated between a second floor framed of 2x10's and a plumbing vent stack. Neither is log, but the floor framing is attached to and supported by log walls, and will settle. The plumbing vent stack is anchored to non-settling members in the basement or crawl space and does not settle.

Another example is the settling between a roof framed of 2x12's and a chimney. Again, neither is made of logs, but because the roof rafters are supported by log walls, this means that the rafters will get closer to the ground as the log walls settle. Therefore, roof framing must not be attached to a chimney unless special steps are taken to accommodate settling.

The list in Section 6.B. is far from exhaustive. Every non-log, non-settling, part of a building must be examined to see if there needs to be an accommodation for settling.

6.C. The log builder knows the special techniques involved in completing a log house and should share this knowledge with the general contractor so that the subcontractors are properly educated about settling and other potential problems.

6.D. Where caulks, sealants, gaskets, and the like are used in contact with logs, these joints must be designed to accommodate shrinkage of the logs without having the joint fail. Trim boards that are scribe-fit to logs shall allow for settling.

Section 7 ROOFS AND ROOF SUPPORT SYSTEMS

7.B. Log roof systems include, but are not limited to, log posts and purlins, ridgepoles, log trusses, and log common rafters. In Section 7, "log" also means "timber."

7.B.1. Severely spiral-grained logs are significantly weaker in bending strength and shall be avoided. Left-hand spiral grain logs are significantly weaker than right-hand spiral grain of equal angle. (See Section 2.A.4 for more on spiral grain.)

7.B.2. All log roof members shall be designed to sufficiently resist all expected loads.

7.B.3. Notches cut into, and any wood removed from a log beam will weaken the beam. One example of this is at the ends of a log beam, no more than one-quarter (1/4) of the depth of the beam, and less if calculations so indicate, shall be removed for a notch (Figure 4.C). It is best to consult an engineer who is familiar with wood structures for help designing log roof systems, and especially for complex roof systems.

7.C. Consider the original height of the beam, the involved settling height and the settling allowance (6% for green logs) to calculate the height of roof beams after settling is complete.

7.D. Roofs for log homes shall protect log beams and log walls from degradation caused by the weather. One good way to accomplish this is to use wide roof overhangs. The effectiveness of roof overhangs also depends upon the height of the wall and the height of the roof drip-edge. Figure 7.D shows how the amount of roof overhang shall be calculated .

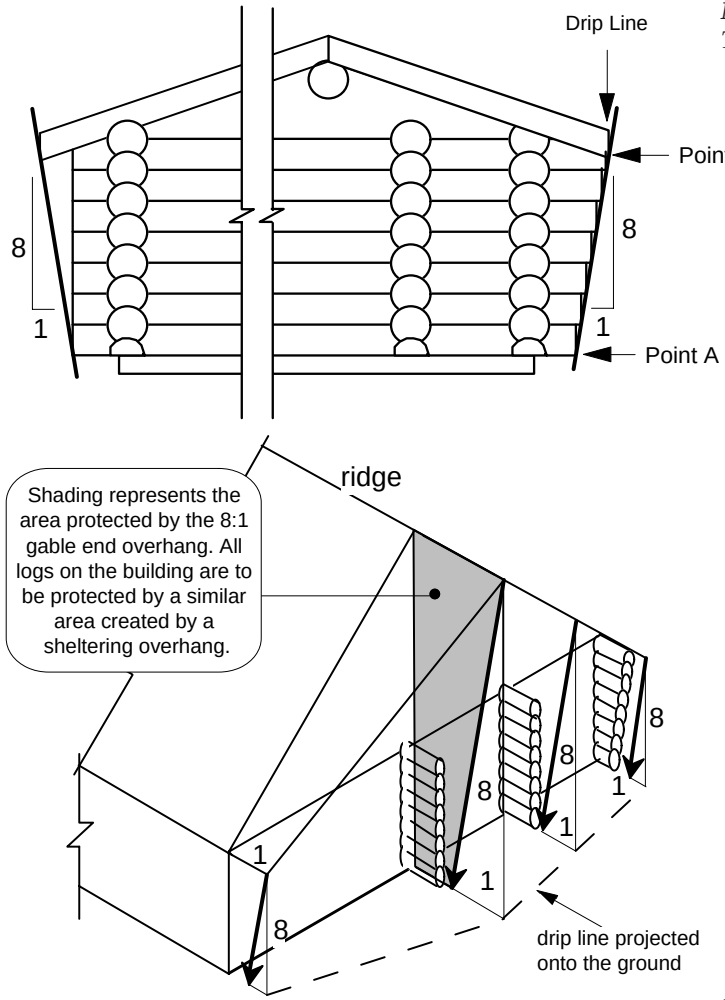


Figure 7.D

7.E. The roof shall protect all roof structural members from the weather associated with the site of the building.

7.F. Log roof beams shall be flattened on top to a minimum width of 3.8 centimeters (1-1/2 inches) where they support lumber or finish materials.

7.G. Where log structural members pass through exterior frame walls they shall be notched slightly to receive interior and exterior wall coverings. Expandable gaskets shall be installed to restrict weather and insect infiltration. Roof members shall be designed to meet structural requirements even after such notching.

7.H. Flashing and an expandable gasket shall be used where conventionally framed gable end walls meet a plate log.

7.I. Roof structures shall be designed and constructed to resist the uplift loads associated with local wind and seismic events.

Notes for Figure 7.D:

The criteria set forth in Figure 7.D is a minimum. This approach to calculating roof overhang is independent of roof pitch and wall height, and relies on a ratio (8:1) to define the relationship between the roof overhang and the logs to be protected. If, for example, the distance that the end of a sill log projects beyond the notch (Point A) is known, then the drip line defined by the roof overhang can be calculated by projecting a line from Point A up and out from the building at the 8 to 1 ratio as illustrated, until this line intersects the bottom of the roof plane (bottom of the rafters), then measure out horizontally here (Point B) to find the minimum roof overhang distance.

Or, if the roof overhang is known, then the maximum projection of log ends beyond the notch can be calculated by reversing the process and beginning at Point B. A reference line is then constructed down and inward toward the building at the 8 to 1 ratio until it intersects the plane of the bottom logs (usually the first floor), then measure out horizontally to Point A to find the maximum allowed length of log extensions. Also check that the log extensions are not shorter than required in Section 2.E.2. Note that the allowed length of log extensions increases as you go higher on the building. That is, log extensions may corbel out at the 8:1 ratio, if desired, though they are not required to do so. At all points around a building, this 8:1 reference line should be used, and no log or log end should project beyond this reference line.

7.E. Log roof beams that extend to the outside of a building need protection from the weather. Purlins, ridgepoles, and posts must not extend outside the drip line of the roof unless special steps are taken, for example wrapping the log-end with a durable metal flashing. Preservative chemicals by themselves are insufficient.

7.F. It is impractical to attach framing lumber or finish materials to the irregular, waney round of a log. Therefore, round log roof beams shall be flattened to a width of 3.8 cm (1-1/2 inches) or more where they support other materials.

7.G. It is common to extend log roof beams, like purlins and ridgepoles, outside over posts to support roof overhangs. This can be a difficult spot to seal from weather infiltration as the log roof beams shrink in diameter. Gaskets help, as do shallow notches to house the sheathing and inside finished wall materials. Make sure that the roof beams are still sufficiently strong even after notching and removing wood.

7.H. The plate log of gable end log walls is flattened on top, often to receive conventional stud framing. It is important that the flat sawn on the plate log does not hold or wick water. A metal flashing is an effective way to directly water away from this intersection.

7.J. Where roof structures are supported on outriggers, which are in turn supported on log extensions, the extension log carrying the outrigger shall be supported by additional log extensions (a minimum of two extensions below the extension carrying the outrigger) in such a way as to support all loads from the outrigger in a manner other than by cantilever action, unless the log extension carrying the outrigger is designed and constructed as a structural cantilever. (See also Section 2.E.4.)

Section 8 ELECTRICAL

Shall comply with applicable codes, with accommodations where necessary for pre-wiring and wall settling allowance. (See also Section 6.B.)

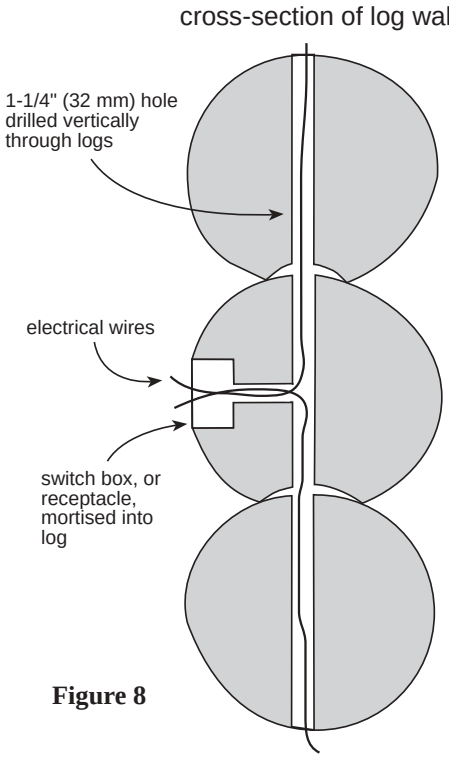


Figure 8

Section 9 PLUMBING

9.A. To comply with applicable codes, with settling considerations. See also Section 6.

9.B. A plumbing pipe shall travel through a log wall only perpendicular to the long axis of the logs, and shall be level or nearly level.

7.J. Log outriggers are roof plates outside of, and parallel to, log eave walls. Do not use just one log extension (log flyway) to support the outrigger unless it can be shown that one extension is sufficiently stiff and strong. In any case, no matter how the outrigger is supported, its means of support must be sufficient. (See Section 2.E for more on log extensions.)

Section 8 ELECTRICAL

Common practice is to pre-drill vertical holes in the log wall, from long groove to long groove, so that the holes are completely hidden from view and no electrical wiring is exposed inside or out. Do not use rigid conduit inside a log wall. Do not attach conduit to a log wall without allowing for settling.

Outlets and switch boxes are usually mortised into a log so that the cover plate is even with the surface of the log so they are flush with a portion of the log surface that has been flattened for this purpose, see Figure 8.

Section 9 PLUMBING

9.A. Investigate carefully the need for settling allowances in all plumbing for log homes. It is usually preferable to run plumbing in frame walls vertically without horizontal offsets, though offsets are possible, if settling considerations are carefully made. Supply pipes to a second floor can allow for settling by incorporating a loop that opens as the second floor loses elevation. Waste and vent pipes can have a slip joint. See Figures 9.A, 9.B, 9.C, and 9.D.

9.B. It is usually not advisable to run plumbing waste, vent or supply pipes through or within log walls. If they must, however, pipes can run perpendicular and level through a log wall. A pipe that runs vertically up through a log wall, or a pipe that runs horizontally within a log wall (for example, lying in a long groove) can never again be serviced without cutting the log wall apart—a drastic event that is difficult to repair.

Because supply lines are known to age, fill with scale and sometimes to leak, and because the venting of sewer gases is a matter of health and safety, it is best to not locate plumbing in log walls.

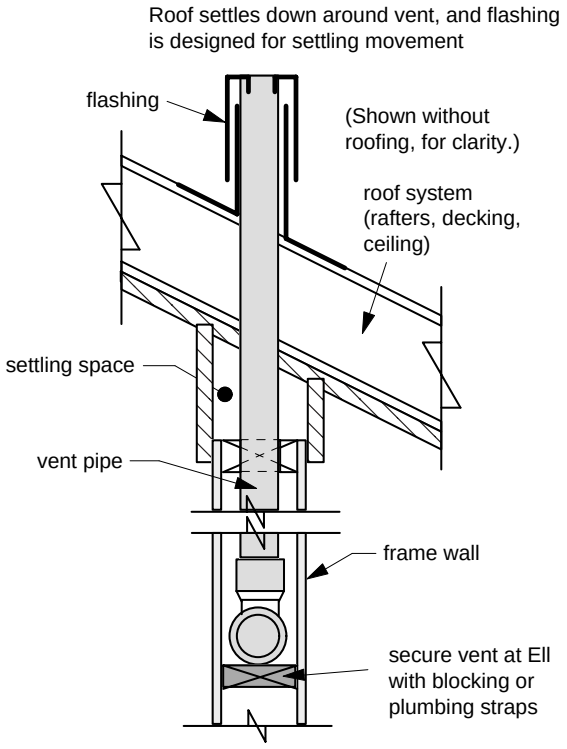
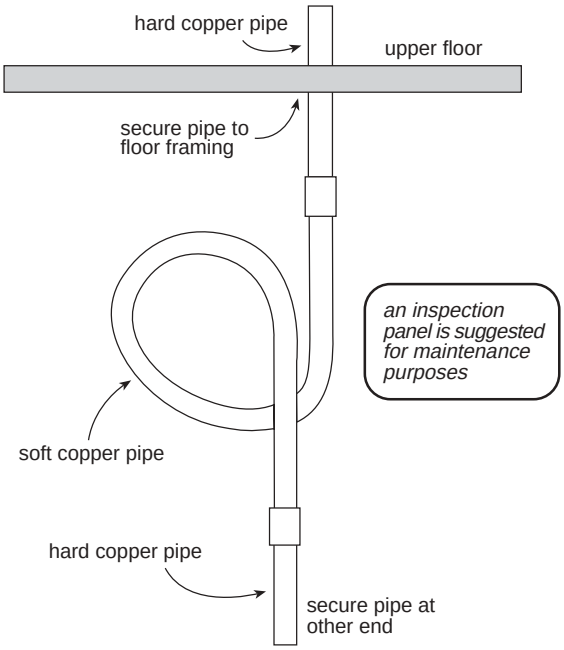
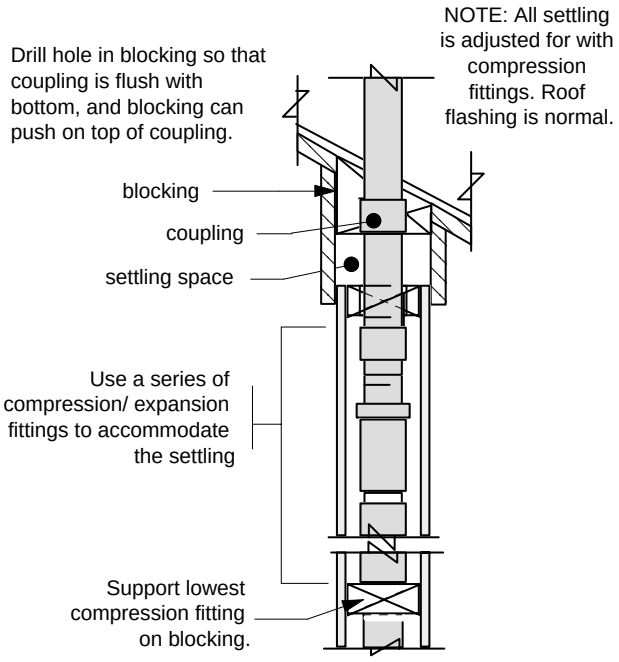


Figure 9.A



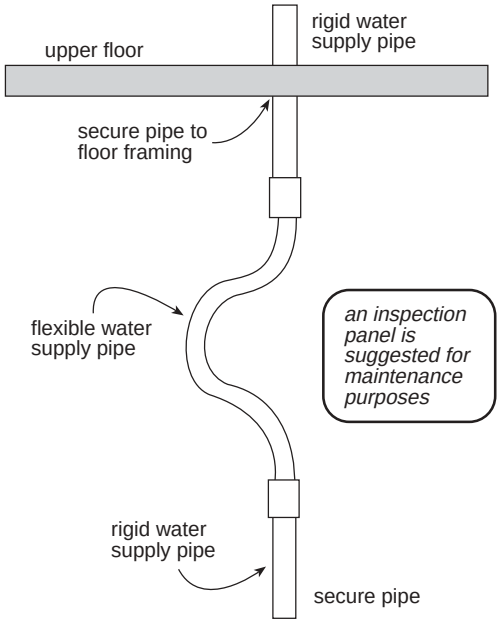
Using a combination of hard and soft copper supply pipe to allow for needed settling in second-story plumbing. The loop of soft pipe opens with settling.

Figure 9.C



Compression/ expansion fittings must be supported at top and bottom in some manner similar to the blocking shown.

Figure 9.B



Using a combination of flexible water supply pipe and rigid pipe to allow for needed settling in second-story plumbing.

Figure 9.D

Section 10 FIREPLACES AND CHIMNEYS

10.A. Shall conform to applicable codes.

10.B. No combustible materials, including log walls, shall be closer than 2 inches (5.1 centimeters) to a masonry chimney.

10.C. Flashing to conform to applicable codes, and to accommodate settling, see Figure 10. See also Section 6.

10.D. No portion of the building shall come into contact with a masonry column unless the assembly is specifically designed to accommodate structural and settling considerations.

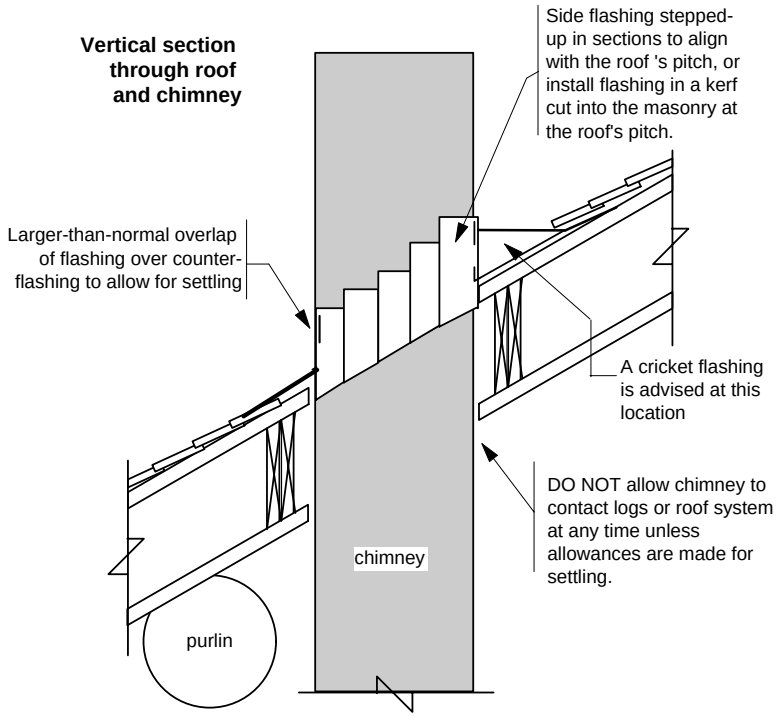


Figure 10

Section 10 FIREPLACES AND CHIMNEYS

10.C. The flashings used where a chimney goes through the roof must accommodate settling and protect against water and weather penetration at all times, including after the building has fully settled. The roof, when supported by log walls, will lose elevation while the chimney will remain the same height. This effect requires that chimneys be flashed and counterflashed (see Figure 10).

Further, the flashing must be tall enough, and must have sufficient overlap when the logs are green, so that even after all settling is complete the counterflashing still overlaps the flashing at least 5.1 centimeters (2 inches), or more if local building codes require or the situation dictates.

Note: Because such tall areas of flashing can be exposed (12 inches—30.5 cm—is not uncommon), it is recommended that flashing material be thicker than normal to protect the flashing from degradation. Remember that the flashing and counterflashing cannot be attached to each other in any way (solder, rivets, or etc.) because they must freely slide vertically past each other to allow settling.

10.D. This refers especially to a common practice in stick-frame buildings-supporting roof or floor beams on the masonry column of the chimney. This must not be done in a log home unless special measures are taken to allow for settling.

It is desirable to position masonry columns during the design process so that they avoid areas in floors and roofs that require structural members. For example, position the chimney so that it avoids the ridgepole.

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