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Dovetails and Broadaxes: Hands-On Log Cabin Preservation

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Cover—The Landmark Ranger Station under construction in 1927 within what is now the Boise National Forest in the Intermountain Region.

Dovetails and Broadaxes: Hands-On Log Cabin Preservation

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Contents

Introduction

This publication is a practical guide for preserving historic log cabins. Most of the guide is devoted to explaining and showing the hands-on aspects of log cabin preservation, such as jacking and cribbing, notching and replacing logs, replacing purlins and rafters, patching, and chinking and daubing. The guide describes how to repair foundations, roofing, windows, doors, chimneys, and interiors. It addresses annual maintenance and appropriate tools. In short, it covers nearly every aspect of log cabin preservation and maintenance.

This guide also presents the history and styles of log cabins, explains how and why to perform condition and historic assessments, addresses the requirements for preserving historic structures, describes how to plan projects, and explains how to work safely, so that you understand why you should use the procedures and methods in the guide.

The information in this guide is not new, but most of it is no longer widely known. Although the primary mission of the U.S. Department of Agriculture, Forest Service, has remained much the same throughout its more than 100-year history, the work has changed dramatically. In the early days, each employee was expected to "be able to take care of himself and his horses in regions remote from settlement and supplies. He must be able to build trails and cabins and to pack in provisions without assistance." Now, most employees are specialists who routinely deal with complex ecological or technical issues. Some still use pack horses and mules or build trails, but they don't hand craft their own offices. Few employees thoroughly know the traditional craft of building with logs, and those who do take their skills and knowledge with them when they retire. The authors wrote and published this guide to keep the knowledge of historic log building methods and materials available.

For many people, the most important reason to retain and repair historic log cabins (figure 1) is that old cabins are interesting. These cabins are visible portrayals of America's past—the materials and tools available at the time that each cabin was built, the skills of the people crafting the buildings, and the needs and purposes of the people who built them. Preserving historic log cabins enables us to touch a tangible piece of our history and to share it with future generations. Appendix A—Preservation Reasons provides more information about the benefits of preserving these cabins.

Figure 1—The Alta Ranger Station in the Bitterroot National Forest, built in 1899. This is the oldest surviving Forest Service building in the Northern Region and may be the oldest surviving log Forest Service building in the Nation constructed specifically for use by forest rangers.

Is your cabin eligible for or listed on the National Register of Historic Places? You need to know before you begin any preservation work so you can determine whether modification or repair work is appropriate. If you don't know the cabin's National Register status, ask your unit heritage staff; they have the information on file. If the cabin isn't owned by a Federal or State government agency, you should hire a professional to evaluate the cabin in the manner explained on the National Register of Historic Places Program: Fundamentals web page at <http://www.nps.gov/nr/national_register_fundamentals.htm>.

In the United States, "historic preservation" often is used as a general term for any work that maintains or restores the historic features of an old building. This use of the term is misleading. The U.S. Secretary of the Interior established four specific treatment approaches for historic buildings, as well as standards and guidelines for implementing the treatments. The treatments differ depending on the historic significance of the building, its current condition, and the goals for its future use. The four treatment approaches are preservation, rehabilitation, restoration, and reconstruction. Appendix B—Preservation Requirements briefly explains these four treatment approaches and the standards for achieving them.

The Forest Service is required by law to carefully care for the historic sites and structures, including log cabins, that the agency owns or funds. Although it is tempting to do whatever seems expedient to repair historic log cabins, Federal and State agencies must follow certain rules, laws, and requirements if the building is eligible for or listed on the National Register of Historic Places. Non-Federal or non-State groups and private individuals also must follow these rules, laws, and requirements during grant-in-aid projects assisted through the National Historic Preservation Fund or if they are using Federal or State funds on buildings that are eligible for or listed on the National Register of Historic Places. Even if you aren't required to comply with the mandates, you will find that they provide valuable guidance during your project. Appendix A—Preservation Reasons, and Appendix C—Preservation History, include information about rules, laws, and requirements.

This guide focuses on cabin **preservation.** The term preservation describes work performed to maintain and repair the form, materials, and features of a historic cabin as it has been occupied through time and to make the appropriate changes and alterations that will keep it useful. Preservation work does not include extensive renovation or major additions. Some upgrading of mechanical, electrical, and plumbing systems and other code-required work is appropriate.

Guiding Principles for Historic Preservation

The following seven principles summarize most of the rules, laws, and requirements for preserving log cabins:

1. **Retain as much historic and existing fabric as possible.**
   "Fabric" is any part of the building's physical structure, such as logs, glass, wallpaper, and decorative details.
2. **Do not leave your imprint on the building.**
   Your job is to protect the historic design and construction of the building. Do not be tempted to improve the original aesthetics or fix original engineering mistakes in visible ways. For instance, if the original rafter ends extended beyond the roof eaves and have rotted, do not fix the rot problem by shortening the rafter ends.
3. **Do not overcraft.**
   Your job is to repair or replace with the same level of craft—be it good or bad—that the historic builders used.
4. **Use only sympathetic treatments.**
   Sometimes a modification may be necessary so that the structure meets current needs and code requirements. "Sympathetic" treatments use similar materials to the originals. For instance, T1-11 siding (plywood sheets grooved to imitate vertical shiplap siding) is not a sympathetic treatment for a log cabin repair.
5. **Match the existing fabric and replace in kind.**
   Stick with the original design and materials. If the original cabin logs are cottonwood, replace them with cottonwood, even though cottonwood is not a durable material. Matching the existing fabric, which may or may not be original, is preferable to speculation. Always use hard evidence, such as existing material, ghosts of past construction, or historic photographs. Do not guess or rely on recollections of past residents or occupants unless no hard evidence exists. Recollections often are faulty. Likewise, although plans and drawings can give clues, builders rarely build exactly according to the plans, so plans and drawings probably are not completely reliable.
6. **Make your work reversible, if possible.**
   Everyone occasionally makes mistakes that may someday need to be corrected.
7. **Document all your work.**
   Assemble as-built plans or carpenter sketches, a written narrative, and detailed photographs to record the work that you completed. Include signboards (figure 2) in your photos, or label the photos in an electronic or physical album. Make an architectural artifacts box with labeled fragments of historic fabric (pieces of flooring or joists, roof shingles, plaster, wallpaper, etc.) that you replace (figure 3). Store the box somewhere in the building that is clean, dry, free of vermin, and out of the way of daily activity, such as the attic, the basement, or a closet. Note the existence and location of the box in the narrative.

In addition to providing the seven guiding principles that summarize rules, laws, and requirements, the author suggests an eighth guiding principle that provides philosophical guidance for the physical work necessary to accomplish effective and appropriate preservation work:

8. **Marry the chain saw to the broadaxe.**
   It's acceptable to use powertools for some work on your historic log cabin, unless the cabin is within a designated wilderness area. The trick is to use powertools when it speeds the work and handtools when it affects the appearance of the cabin. Whether you use handtools or powertools, craftsmanship is vital to preservation.

Figure 2—The photographer made and placed a signboard in this photo to show that the circular fragment is a 4-inch-diameter drain tile found during a restoration project on April 8, 1992, at the northwest corner of the Judith Guard Station (Lewis and Clark National Forest, Northern Region). Sign boards in photos, unlike other photo captions, can't be separated and lost from the photo.

Figure 3—The restorers of the 1916 Paschoal Social Hall in Kalaupapa National Historical Park, Hawaii, created this architectural artifacts box in 1998 to safely store fragments of the historic materials they replaced.

Anatomy of a Log Cabin

The author uses certain technical construction terms consistently throughout this guide. Even if you have worked in building maintenance or construction for years, you may not be familiar with all the terms. Many once common techniques and terms are no longer common at all, and construction terms may have different meanings to people in different parts of the country.

The drawings of a log cabin (figure 4) and an ordinary early 20th-century house (figure 5 and table 1) illustrate the terms used in this guide to describe parts of buildings. You may want to bookmark this page so you can flip back to it whenever you encounter an unfamiliar term. Appendix D—Glossary, lists and defines log cabin construction terms. You also may want to bookmark it.

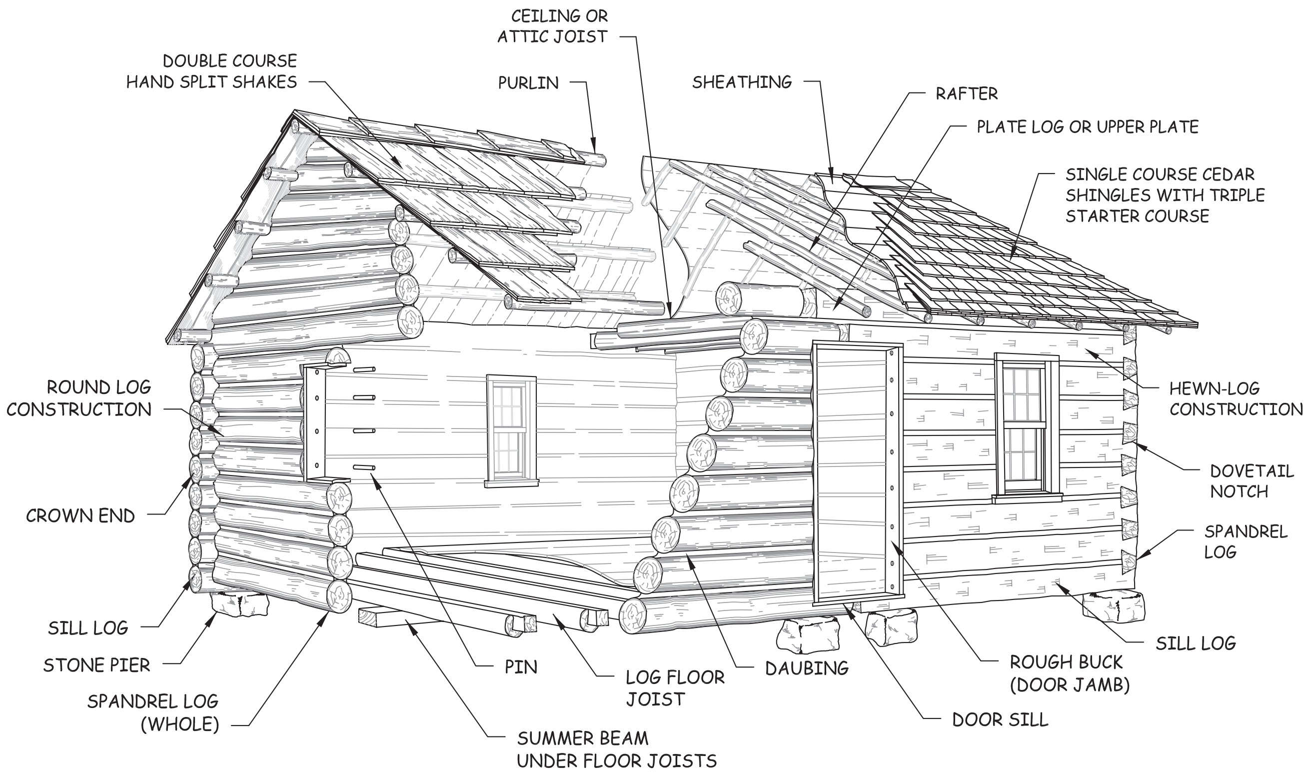


Figure 4—This detailed drawing shows all the common "parts" of a log cabin.

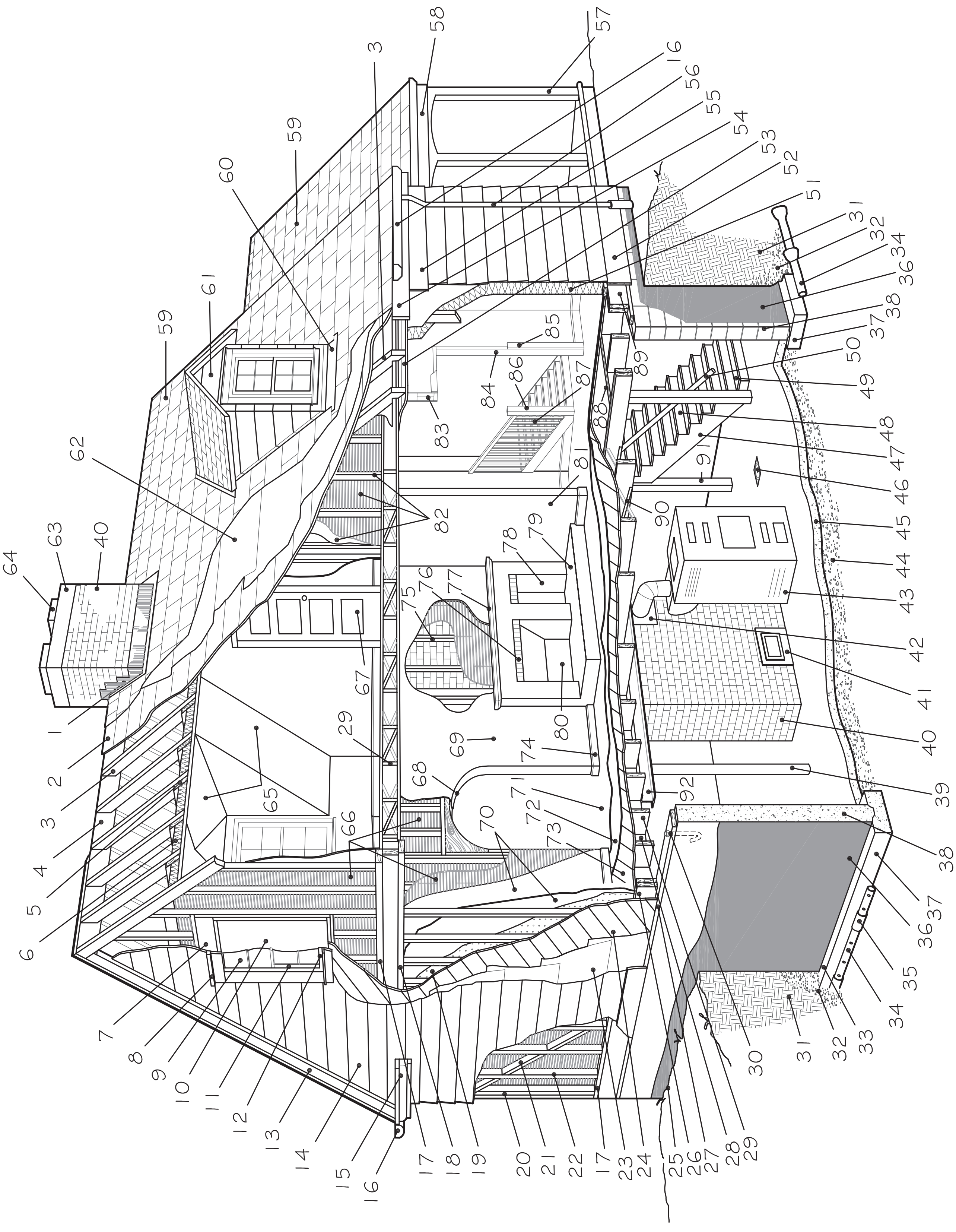


Figure 5—This detailed drawing shows all the common "parts" of a typical early 20th-century house. The numbers on the drawing correspond to the items listed in Table 1—House Parts Dictionary.

Table 1—House Parts Dictionary.

Part Number	Item	Part Number	Item
1	counter flashing	47	stair stringer
2	roof sheathing	48	stair riser
3	rafters	49	stair tread
4	ridge board	50	stair rail or handrail
5	ceiling joist	51	wall insulation
6	ceiling insulation	52	weather board
7	window header	53	soffit
8	drip cap molding	54	fascia
9	glazing or window glass	55	frieze board
10	rough opening	56	down spout
11	window sash	57	porch post or column
12	windowsill	58	porch frieze board
13	gable rake molding or barge board	59	shingles
14	bevel siding	60	base flashing
15	cornice return	61	dormer
16	gutter	62	(asphalt felt) roofing paper or roofing felt
17	floor plate or bottom plate or sole plate	63	chimney cap
18	top plate	64	flue liner
19	drywall lath or gypsum lath	65	angled ceiling
20	corner studs	66	wood lath
21	diagonal bracing or wind bracing or shear bracing	67	passage door or interior door
22	wall studs	68	plaster arch
23	(asphalt felt) building paper	69	bearing wall
24	diagonal wall sheathing	70	plaster
25	grade line	71	finish flooring
26	double edge joist or rim joist	72	underlayment
27	sill plate	73	subfloor
28	solid blocking	74	base molding
29	floor joist	75	furring strips
30	anchor bolt	76	lintel
31	backfill	77	mantle
32	drain rock	78	wood box
33	foundation cove	79	hearth
34	drain tile or foundation drain	80	fire box or fireplace
35	joint cover	81	partition wall (full height, non load bearing)
36	waterproofing	82	(back of) knee wall
37	footing	83	header
38	foundation wall or stem wall	84	cased opening
39	pipe column	85	trim
40	chimney	86	newel post
41	ash pit cleanout	87	banister or baluster
42	thimble	88	joist trimmer or joist header
43	furnace	89	rim joist or band joist
44	aggregate fill or base	90	cross bridging or cross bracing
45	floor slab	91	post or column
46	floor drain	92	steel beam

A Brief History of Log Construction

Not all log buildings are log cabins. Some log structures, including many built in the 20th century, are more polished, larger, or more elaborate than a log cabin. A log cabin is a simple one- or one-and-a-half-story structure (figure 6), usually having a somewhat rough appearance. Although techniques explained in this guide may be similar to those used for other log structures, this guide concentrates on log cabin preservation.

Many Americans view log cabins nostalgically as the traditional American pioneer home, representing cultural characteristics such as wholesomeness, humility, and honesty. People have held this viewpoint since at least 1840, when the supporters of presidential candidate William Henry Harrison adopted the log cabin as a campaign symbol.

American settlers didn't invent log cabin construction, and the first English and Spanish colonists didn't construct buildings using logs. Northern and Eastern Europeans have used stacked log construction since at least 800 B.C. In the early 1600s, Finnish and Swedish settlers brought the stacked log construction technique with them from Scandinavia to what is now Delaware and Pennsylvania. Because much of the American frontier was well endowed with trees but not with sawmills, and log buildings could be handcrafted relatively quickly using axes and crosscut saws, settlers adopted this style of construction widely and passed it along to others.

During the 1600s and 1700s, European immigrants from Switzerland, Germany, and Ukraine brought their own log construction techniques to America. Settlers used logs to build houses, businesses, schools, churches, barns, and other structures as they pioneered in forested areas. In the Mississippi Valley, French fur traders and settlers introduced vertical log construction during the 1600s. In parts of California and in Alaska, Russian traders and colonists built log buildings during the late 1700s and early 1800s. Hispanic influences are apparent in many historic log structures in the Southwestern States.

Figure 6—The Jubilee Guard Station is a one-and-a-half-story log cabin built in 1905 in the Escalante District of the Dixie National Forest, Intermountain Region. Located at an elevation of 9,800 feet on the Aquarius Plateau in southern Utah, it's one of the oldest remaining guard stations in the State.

As populations became denser and industry developed during the mid-1800s, nailed-together, balloon-frame construction using dimensioned lumber replaced log construction and also traditional mortise-and-tenon joinery in most of the country. During this time, people often viewed log structures as temporary first homes to be replaced with respectable frame or masonry buildings as soon as the homeowners could afford them.

In the late 1800s and early 1900s, rustic-style, architect-designed log buildings became fashionable for the often luxurious vacation retreats of wealthy Americans in the Adirondack Mountains region and near western public lands (figure 7). The Old Faithful Inn at Yellowstone National Park (figure 8), built in 1903, is often considered the pinnacle of this log-lodge style—which is a far cry from a log cabin. In the late 1890s, the American Craftsman building style developed as part of the Arts and Crafts movement. People considered this style's emphasis on natural materials more compatible with forested settings than other styles. Many State park, national park, and Forest Service buildings constructed during the 1930s and 1940s adopted log construction with American Craftsman details. The Civilian Conservation Corps built many of these log buildings.

Today, log construction remains popular, particularly in the West where it is viewed as appropriate to the natural setting and a fitting architectural style for those who consider themselves the inheritors of the spirit of rugged independence exemplified by American pioneers. Few people today build their own new log structures using just an axe and crosscut saw. Now, contractors use powertools, sophisticated jigs, and cranes to hoist the logs into place.

Figure 7—Craftsmen constructed this spacious summer home within the Boise National Forest, Intermountain Region, in 1938.

Figure 8— Architect Robert Reamer designed the Old Faithful Inn in Yellowstone National Park with elaborate log and stone detailing. The inn has been carefully maintained to preserve its original character for more than 100 years.

Building With Logs in the Forest Service

Log buildings have been constructed by and on behalf of the Forest Service since the earliest days of the agency, especially in the West. In the first few years after Congress established the Forest Service, a new ranger might be expected to construct a cabin that would serve him and his family as both a dwelling and an office in a location that would provide relatively easy access to the lands the ranger was responsible for managing. Later, the agency developed standard plans for ranger station buildings that could be modified to suit local conditions. The Forest Service sometimes hired local builders to help construct those buildings. During the Great Depression, the Civilian Conservation Corps constructed a number of buildings for the Forest Service, sometimes using standardized regional plans.

By the early 1940s, W. Ellis Groben, the Chief Architect of the Forest Service, and Clyde P. Fickes, a structural engineer in the Northern Region Regional Office, determined that detailing effective log construction practices would be beneficial to the Forest Service. They wrote “Building with Logs” in 1944. In 1945, the Forest Service published it as “USDA Forest Service, Miscellaneous Publication No. 579.” This publication is available at <http://www.fs.fed.us/eng/facilities/documents/build_with_logs.pdf>.

Styles: Not All Log Buildings Are Created Equal

People tend to prefer doing things as they always have, unless they have a good reason to change. When immigrants came to America, they brought their cultural traditions and their construction techniques. In many cases, building types and styles developed in the "old country" worked fine in the New World. In other cases, they really didn't make sense in the new climate, nor were the same building materials available. People sometimes retained traditional building shapes but used whatever materials were available. Climate sometimes encouraged them to change the shapes of their buildings, but they kept familiar details. Other times, they adopted both materials and forms that others had used successfully in the area. Because of this mix of construction traditions, climates, and available materials in America, variations multiplied, even in simple building forms such as log cabins.

For example, foundations for historic log cabins vary from nothing at all to full concrete footings and stem walls. Cabins constructed without foundations usually had dirt floors; the builders intended them as temporary shelters. More common were log pilings or log sleepers that supported sill logs and floor joists. Most builders set log cabins on stone piers or a continuous course of mortared (figure 9) or dry-laid stones. They sometimes filled the spaces between supporting piers with mortared or dry-laid stones (figure 10). They varied the height of the foundation walls or piers, depending on the climate. People in the South often used fairly tall piers under cabins to allow air to circulate. Concrete foundations and basements under log cabins didn't become common until the early 1900s, but people did dig root cellars under some earlier cabins.

Most log cabins are one of four basic cabin plans, or a variation thereof. The most common plan is the single pen (figure 11), a rectangular or square cabin with a door under the roof eaves. People often added porches to provide protection for the door and outdoor living space. The saddlebag (figure 12) or double pen plan is two side-by-side single pens that usually share a central chimney. Saddlebag buildings frequently grew from single pen cabins when the owners added a second

Figure 9—The Ranger's House at the Crandall Ranger Station (Shoshone National Forest, Rocky Mountain Region), built in 1935, has a mortared stone foundation.

Figure 10—The people who restored this pre-1914 storage cabin at the Stolle Meadows Guard Station (Boise National Forest, Intermountain Region) carefully replaced the dry-laid stones between the rock corner piers after they replaced the sill and spandrel logs.

pen onto the chimney-end wall. The dogtrot cabin (figure 13) is made of two separate cabins joined by a central open-air passageway under a continuous roof. It is commonly considered a southern-style cabin because the open middle provides shade for outdoor activities and encourages air movement that cools the structure. Examples of this floor plan are scattered throughout the country. The Rocky Mountain-style cabin (figure 14) probably evolved as a response to the heavy snowfall in the Rockies. Rocky Mountain cabins have a door in the gable end. The door is usually sheltered from sliding snow by an extension of the cabin roof that forms a porch.

Builders constructed all these cabin types in various sizes, with or without inside walls that defined separate rooms. People sometimes built larger cabins with central chimneys dividing the two main rooms; but, because cabins usually were small, most people put their fireplaces or wood stoves on one end wall. As the owners' fortunes improved, they sometimes added end or ell additions (figure 15), full or partial second floors, exterior siding, or plaster on the interior walls and ceilings.

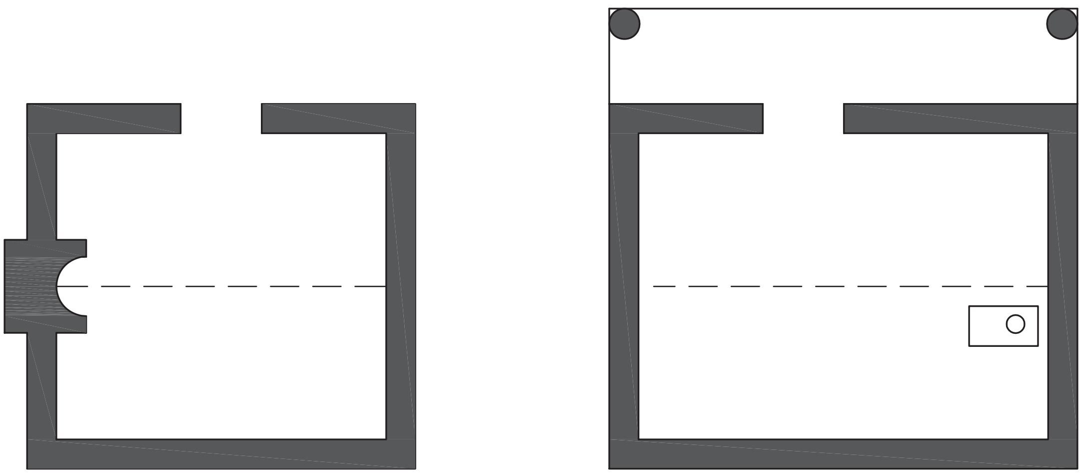


Figure 11—These drawings show two typical single pen cabin plans. The fireplace or wood stove typically is on a gable end. The door is on the side under the eaves or under a side porch.

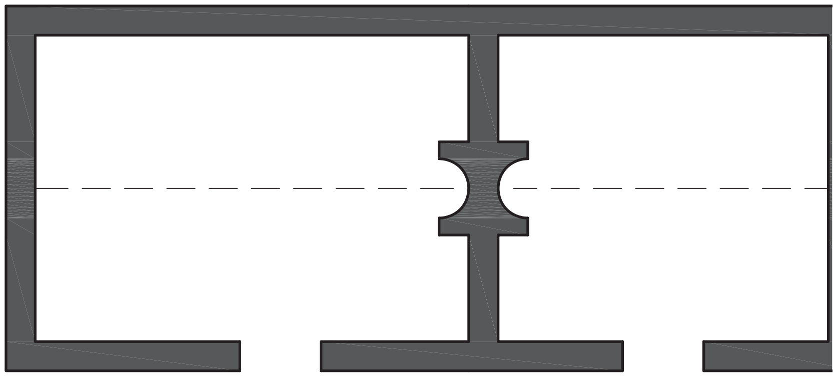


Figure 12—A typical plan for a saddlebag or double pen cabin with two fireplaces served by a central chimney.

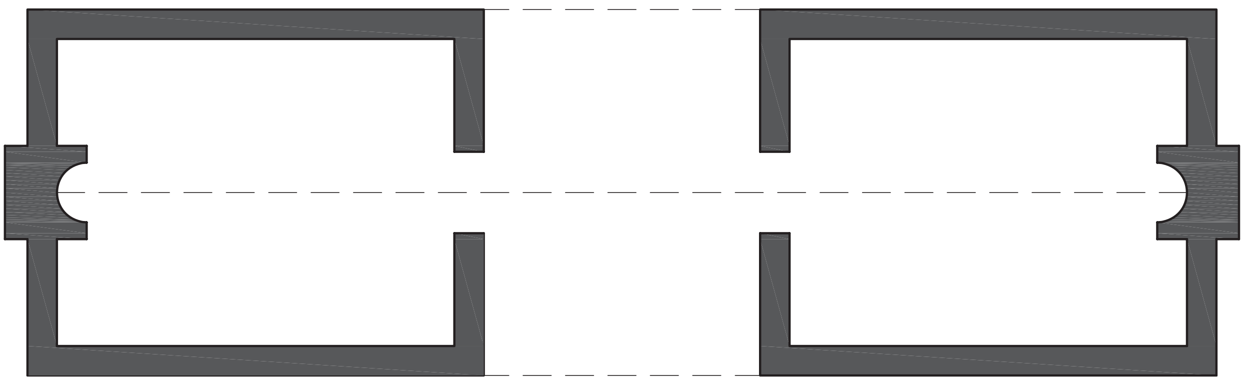


Figure 13—A typical plan for a dogtrot-style cabin. The doors open onto a covered breezeway between the two single pen cabins, and fireplaces are located at each end.

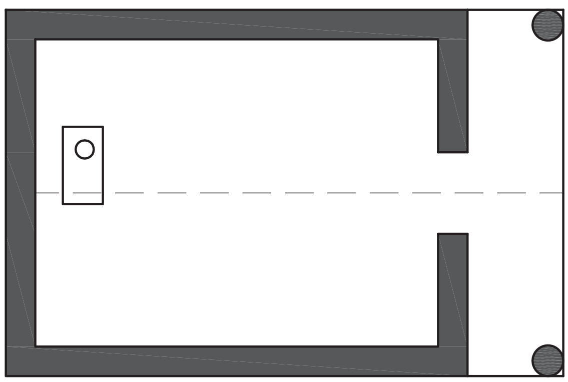


Figure 14—A typical plan for a Rocky Mountain-style log cabin. The door opens onto a covered porch on the gable end.

Figure 15—The builders enlarged Checkerboard Ranger Station (now within the Helena Ranger District) of the Helena National Forest, Northern Region, by adding a two-story log wing with a roof running perpendicular to the original log building.

Farmers and settlers tended to construct log cabins from the most durable tree species they could find in a handy diameter. They frequently used chestnut and white oak trees in the East and Midwest; cedar in the Pacific Northwest; and ponderosa pine, Douglas-fir, or larch in the Rocky Mountains. These species provided relatively long, straight, rot-resistant logs. Sometimes they used less durable but lighter species for the upper log courses because these courses didn't need to be as rot resistant. During the Gold Rush era in the interior West, miners constructed cabins of whatever wood they could find; even cottonwood, which isn't very durable. The miners didn't intend to stay long.

Builders usually constructed cabins with round logs, but sometimes they hewed logs to provide fairly flat exterior and interior wall surfaces. They usually removed the bark before stacking the logs, but they sometimes left the bark in place, especially on temporary structures. Where they could locate large-diameter logs, builders sometimes sawed them lengthwise into two halves so that a single log could provide two wall courses, with the flat side facing the interior or exterior.

To secure the stacked logs, builders used a variety of corner notching and other fastening systems. Common notching techniques included: saddle notching (figure 16), "V" or steeple notching (figure 17), half-dovetail notching (figure 18), and full-dovetail notching (figure 19). Among these notching techniques, saddle notching requires the least time and skill to accomplish. Full-dovetail notching creates the most secure corner, but also requires the most time and skill. Square notching (figure 20) must be secured with pegs or spikes because the log ends don't interlock. Other corner fastening methods, such as step and lock (figure 21), corner posts (figure 22) without or with tenons (figure 23), and "hog trough" boards nailed to the ends of stacked logs (figure 24) were less common. Log cabin builders sometimes held each successive course of logs together with metal spikes or wooden dowels. If the builders used spikes or dowels, they usually drove them through near the middle of the wall, although some builders drove connecting spikes along the full length of the wall. An extended log end or "crown" sometimes protruded beyond the corner notches of cabins built during the period when the American Craftsman style was popular.

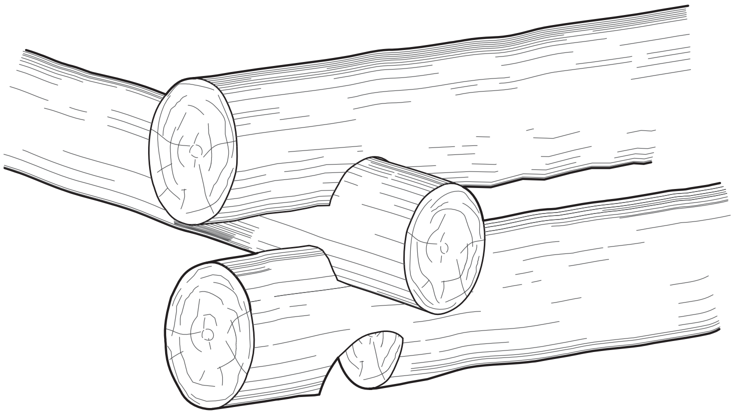


Figure 16—This drawing shows a saddle notch and how the notch locks the logs together.

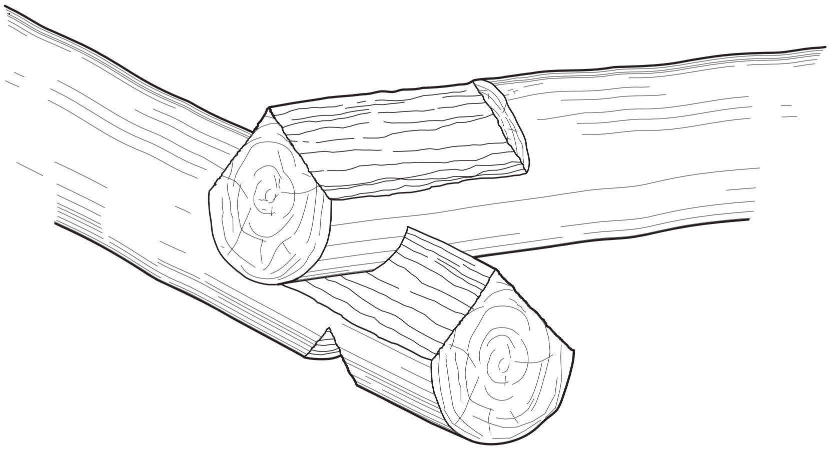


Figure 17—This drawing shows a "V" or steeple notch and how the notch locks the logs together.

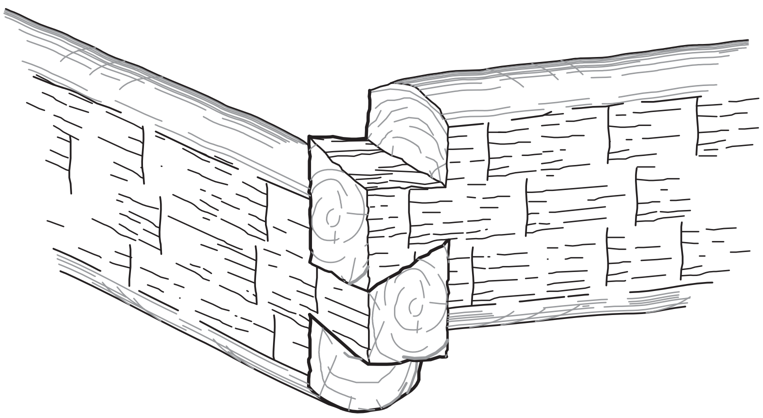


Figure 18—This drawing shows a half-dovetail notch and how the notch locks the logs together.

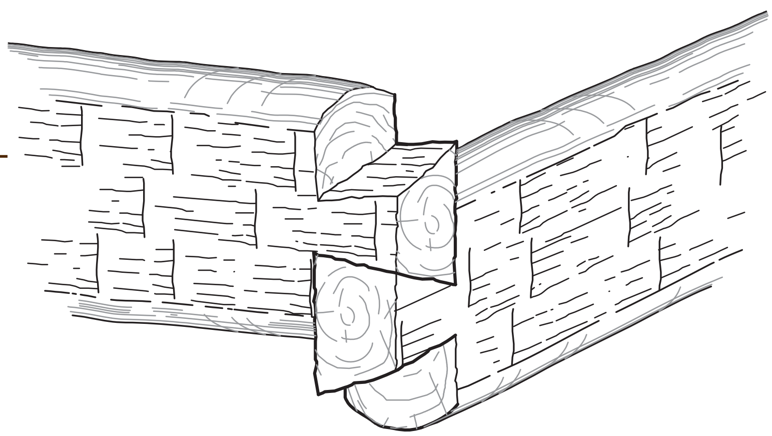
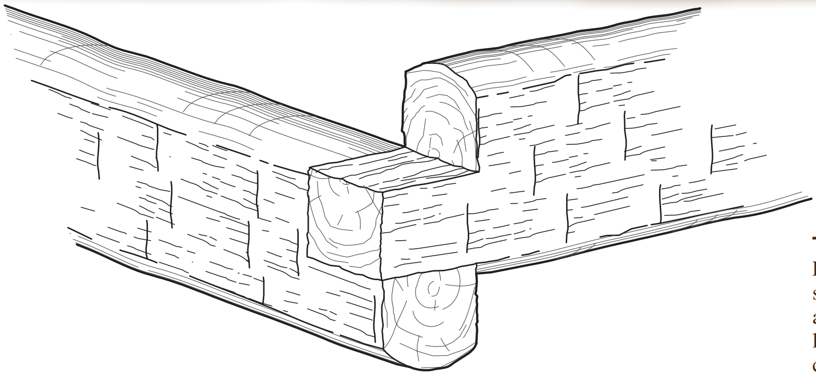


Figure 19—This drawing shows a full-dovetail notch and how the notch locks the logs together.



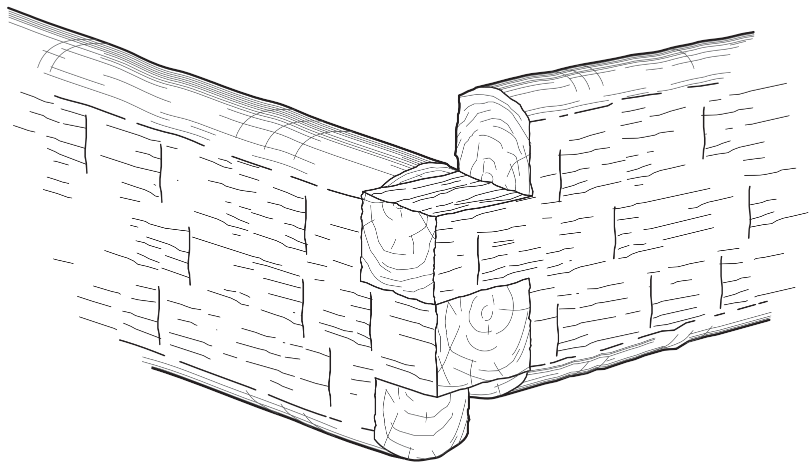


Figure 20—These two drawings show two square notching methods and why this notch doesn't lock logs together but must be pinned to create a sturdy corner.

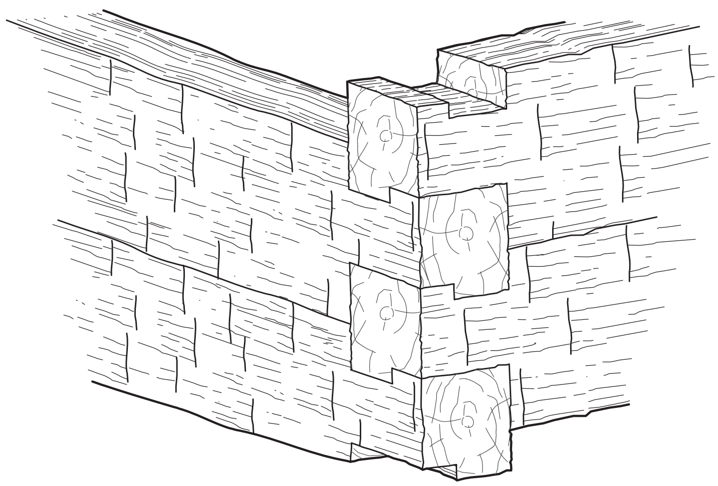


Figure 21—This drawing shows a step and lock notch and how the notch partially locks the logs together.

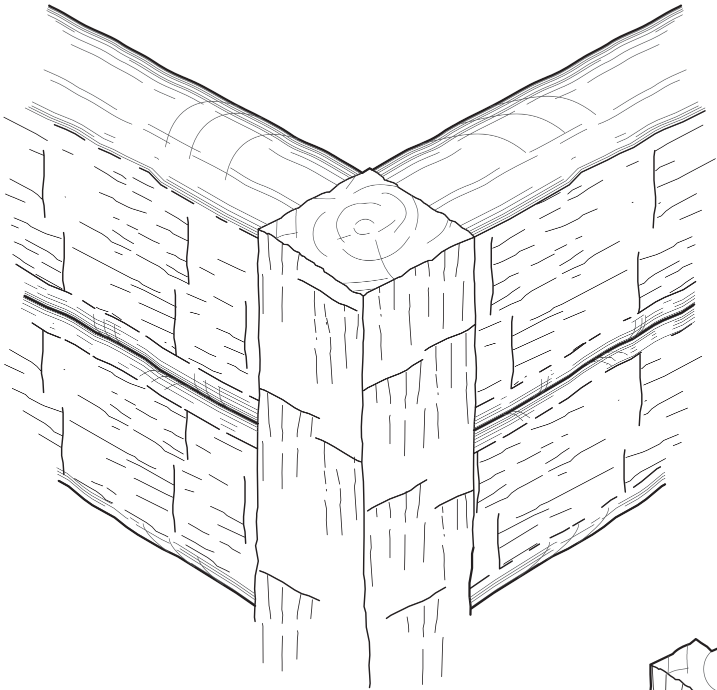


Figure 22—This drawing shows how logs abut a corner post.

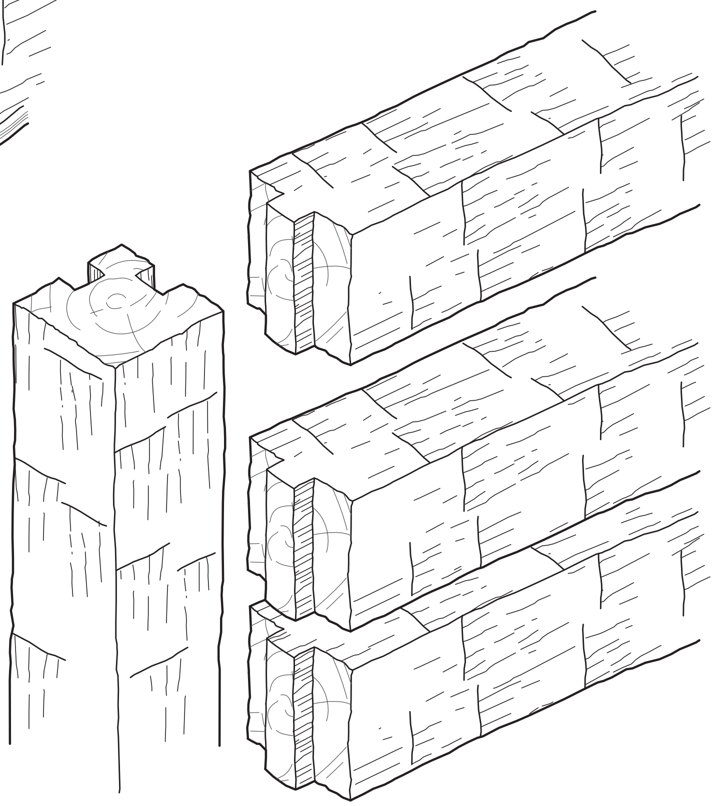


Figure 23—This drawing shows how log tenons fit into a mortised corner post.

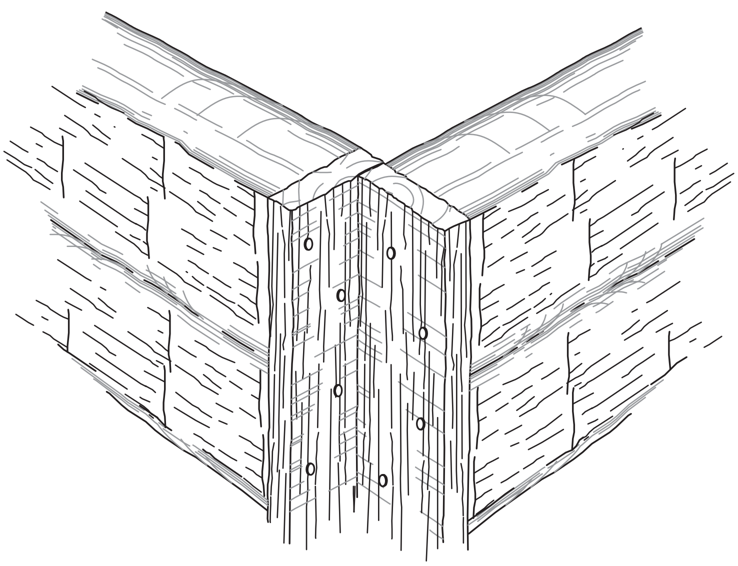


Figure 24—This drawing shows "hog trough" boards nailed to stacked logs to create a corner.

Sometimes builders carefully hewed logs flat between courses or coped (scribed and shaped) (figure 25) them to fit together so that little or no gap existed between the stacked logs, achieving a nearly weather-tight wall without chinking and daubing. Creating this tight fit with handtools required a lot of time and skill.

Log cabin builders usually chinked and daubed cabin walls to keep weather out. Chinking is material used to fill the horizontal spaces between logs. Chinking typically consisted of whatever builders could find nearby and could conveniently stuff into the spaces between logs. Chinking often consisted of wood or stone slabs packed with moss, oakum, clay, or dung.

Daubing is the finish layer that usually looks like dried mud or mortar, typically consisting of a sand, clay, and lime mixture. After 1900, builders sometimes added Portland cement to daubing mixes. They often sloped daubing (figure 26) to protect the tops of logs and to shed rain. Sometimes builders used tightly fitted quarter poles or narrow wood strips instead of, or in addition to, daubing. Even when builders hewed

Figure 25—The builders coped the logs of this D-1 type lookout so that they fit tightly. This lookout was relocated to the Northern Region's Aerial Fire Depot and Smokejumper Center as part of an interpretive display.

Figure 26—The builders sloped this unusually white daubing to protect the tops of the logs. A narrow wood strip provides a solid lower edge for the daubing.

logs flat between courses or coped them, they frequently used chinking and daubing to provide additional weather resistance.

Builders sometimes covered log cabins with shingles, sawn-wood siding (figure 27), stucco, or whitewash to provide a more finished and prosperous appearance and to help protect the logs from weather and insects. Sometimes they applied this outer finish immediately after they built the cabin and sometimes they applied it later.

Although simple gable roofs framed with purlins or rafters are most common for log cabins, builders used a variety of styles (figure 28). While they mostly used wood shingles or shakes for roof materials, they sometimes used other materials, including sod (figure 29).

Appendix E—Log Building Origins and Styles provides more detailed information about log building plans, logs, joining, weatherproofing, roofs, foundations, and chimneys.

Figure 27—This log cabin in Frisco, CO, has clapboard siding on the front.

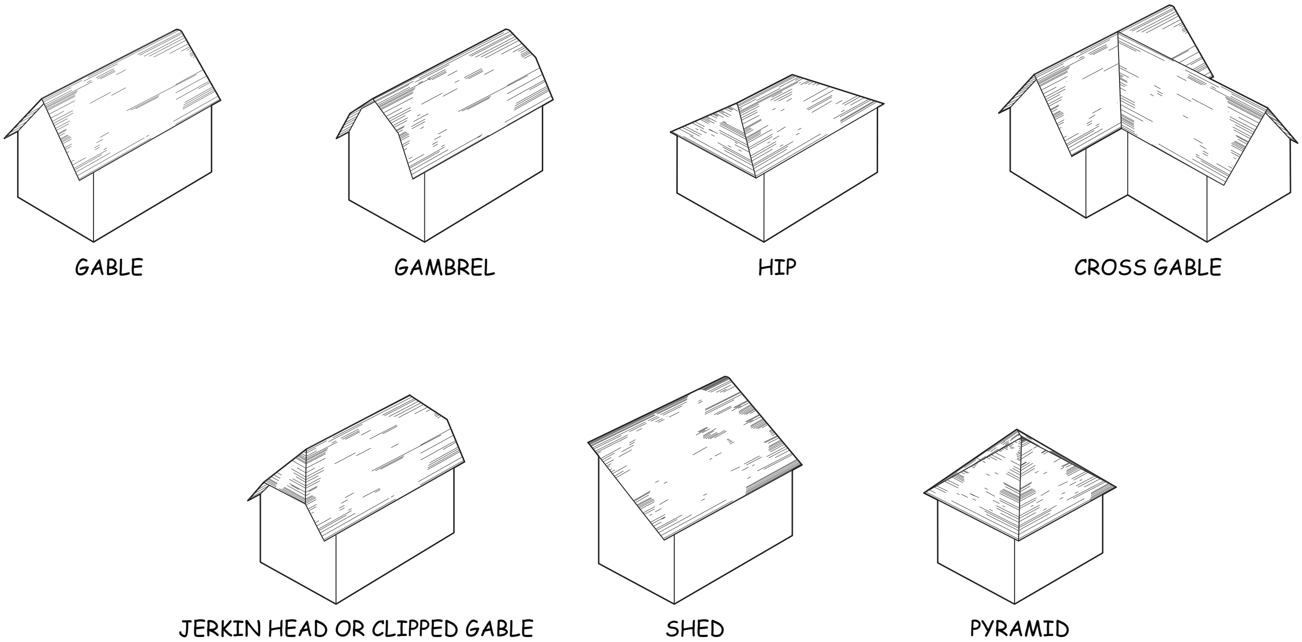


Figure 28—This series of labeled drawings shows common roof styles for log buildings.

Figure 29—These historic log jail buildings at Bannack State Park in Montana have sod roofs.

Read Your Building: Condition and Historic Assessment

Historically, people from all cultures have used similar criteria when selecting places to camp or settle. If a location looked desirable to the people building a log cabin, it probably looked desirable to the people in the area before the cabin builders arrived, and they may have left evidence of their occupation.

It can be fascinating to determine the previous uses of a site. Preservation work normally includes disturbances to sites and removing finishes and structural elements. Take advantage of these disturbances to learn about the past via archaeological investigation. If a Federal or State government agency owns a building or site, or if some or all of the funding for cabin preservation work is from Federal or State sources, such investigations are required to ensure the work you do will not adversely affect evidence of past use.

An archaeological investigation can be simple or complex, depending on the historic significance of what you find during the investigation. For Federal or State projects, contact your unit's heritage resources specialist. If no Federal or State funding is involved, you can contact a local archaeologist to conduct an archaeological investigation. Your State's historic preservation officer (SHPO) maintains a list of qualified professional archaeologists. You can find contact information for your SHPO at <http://www.ncshpo.org/shpodirectory.shtml>.

Contact the heritage resource specialist or archaeologist as soon as you begin contemplating preservation work; investigations can take a while to complete. Although the work could be as simple as a phone conversation with the specialist or archaeologist, followed by a few small test holes (dug where you need to excavate for a foundation anyway) and screening the excavated dirt (figure 30), the work can be a lot more extensive. Scheduling the investigation could take even longer than the actual excavation work, so plan ahead. If an archaeological site is clearly present or if you already know that previous residents left a historic trash dump, outhouse, or other debris, begin talks with the heritage resource specialist or archaeologist at least a year before your planned preservation work.

Figure 30—Forest Service employees constructed Longview Guard Station (Bighorn National Forest, Rocky Mountain Region) in 1909 on a site with a permanent spring nearby. The volunteer group Teacher Restoration Corps, under the direction of Bighorn National Forest East Zone Archaeologist Bill Matthews, conducted test excavations around and under the cabin foundation before beginning restoration work on the cabin. The investigation showed that the original cabin builders had scraped away all the soil containing prehistoric materials before they started construction, so the corps didn't need an extensive archaeological investigation before beginning the restoration work.

Some log cabin sites have amazing evidence of prehistoric use buried beneath historic debris. Artifacts may be more than 10,000 years old or from the early 1900s. Those who used the site in the past may have left projectile points, such as arrowheads or spearheads (figure 31), stone or metal tools, hearths or firepits, animal bone fragments, artifacts from a battle, patent medicine bottles (figure 32), crockery or china, toys, or a host of other interesting items. Specialists and archaeologists can piece this evidence together to make determinations, such as what tribe or nationality of people lived there, what occupations they had, what medicines they used, what they ate, whether they had children, and possibly even what china pattern they used (figure 33).

After looking beneath the ground surface, the next step is to conduct a condition and historic assessment of the cabin. Before planning or beginning preservation work on the cabin, you must make decisions about which portions of the cabin are historically significant and should be repaired or replaced in kind and which portions can or should be altered or removed. A condition and historic assessment will provide the information you need to make those decisions. If a Federal or State government agency owns the cabin, or if some or all of the funding for cabin preservation work is from Federal or State sources, you may need to make these decisions with input or approval from the SHPO. Check with your heritage resource specialist or archaeologist for the requirements.

If the cabin is important or you know that there is a long history of use at the site, engage a preservation specialist or historic architect to examine and evaluate the cabin's physical condition and investigate the cabin's history and design. You will need the specialist's or architect's professional expertise to properly evaluate the complex issues at the cabin. If you don't expect the issues at the cabin to be complex, an engineer, architect, experienced facilities maintenance worker, or builder may be able to perform an adequate assessment using the information provided in this section, especially with initial guidance from a preservation specialist or historic architect.

The cabin assessor must physically examine and measure the structure, photograph or make video recordings of the building's condition and distinctive features, identify and document structural and cosmetic damage and its causes, identify any previous changes or repairs, and complete architectural drawings. The more comprehensive the documentation, the better. You can refer to the assessment notes, photos, and drawings when planning your preservation work and after your work is underway. The documents will serve as historical records.

Figure 31—Forest Service archeologists uncovered this assortment of projectile points around the Hogback Cabin (Lolo National Forest, Northern Region). The site was clearly occupied long before homesteader Charles Gerhardt constructed the cabin between 1913 and 1915. The archaeologists investigated the site because of a potential mining claim on the creek behind the cabin and conducted another investigation later as part of a restoration project. The investigations uncovered arrowheads and spearheads in different locations near the cabin.

Figure 32—Forest Service archeologists uncovered this assortment of glass bottles before and during a restoration project at the Hogback Cabin (Lolo National Forest, Northern Region) from 1993 through 1995. The cabin is now available for recreation rental.

Figure 33— Forest Service archeologists recovered this glass Heinz bottle and part of an ironstone bowl during site testing at log cabins within the Questa Ranger District (Carson National Forest, Southwest Region).

The condition assessment documents the current condition of each part of the structure and identifies structural problems and cosmetic deterioration or damage throughout the building, from the bottom of the foundation to the top of the chimney. The inspection includes any plumbing, electric, or heating devices and systems. Forest Service and Bureau of Land Management (BLM) employees can obtain guidance on condition assessments from the report, "So That's Why It's Always Cold in Here: A Guide for Conducting Facilities Condition Assessment Surveys," available to Forest Service and BLM employees at <http://fsweb.mtdc.wo.fs.fed.us/php/library_card.php?p_num=0473 2839>. You may also need a structural engineer's investigation and recommendations for structural repair design.

The historic assessment documents significant features and details that represent a particular historic period, style, or owner; add a finishing touch to the building; or indicate the history of the area. Such features and details may include Craftsman-style eaves, names and dates carved into or written on the building (figure 34), Victorian beadwork, porch rails made of tree branches, or flagstone porches.

The historic assessment identifies past building repairs and modifications. Repairs that match the original material and harmonious modifications that keep the building useful are important to the continued existence of a cabin. Other repairs and modifications may not be the best thing that ever happened to the cabin. For example, repairs may be falling apart or may not match the original material or appearance of the cabin (figure 35). The people who repaired the cabin may have moved doors and windows from their original location (figure 36). They may have replaced logs with a different species or size, or even with concrete (figure 37). Modifications that occurred more than 50 years ago may have "acquired significance," which means that the modifications are now old enough to be part of the building's history.

Figure 34—The initials "EB" (most likely for Ernest Betasso), made by hammering bullet casings into the end of a log, are an example of a detail that should be recorded in a historic assessment. This interesting feature was found at the Betasso Ranch Preserve "homestead cabin" near Boulder, CO.

Figure 35—Someone “repaired” the daubing on this cabin with a concrete mortar mix and an odd use of wood scraps. The “repairs” don’t match the original materials or methods and probably are contributing to further decay of the logs.

Figure 36—The newer logs under the window are evidence that someone removed a door from this location and installed a window. The window originally may be from another location in the cabin. If there are similar log inserts at window height elsewhere in the cabin, they probably indicate the original location of the window.

Figure 37—When some of the lower logs of this building rotted out, someone added a concrete wall to replace the sill logs, spandrel logs, and some wall logs; added a concrete foundation; and replaced some of the wall logs with new logs. One of the new logs was roughly debarked, making it look different from the older logs. Concrete is not an appropriate "repair" for rotted logs.

Tools for Performing an Assessment

To conduct a condition and historic assessment, use the following common tools (figure 38):

- Camera and video camera
- Paper and pencil
- Flashlight (best choice—battery-powered spotlight)
- Tape measure (also useful—6-foot folding ruler)
- Pocket knife or other small knife
- Building level, laser level, or stringline and line level
- 2- and/or 4-foot level
- Plumb bob
- Claw hammer (also useful if available—geologist's hammer)
- Pry bars and flat bars
- Pliers
- Vise grips
- Adjustable wrench
- Multibit screwdriver
- Awl
- Framing square
- Extendable mirror

Structural engineers also may use moisture meters and advanced technology, such as stress-wave timing equipment or drill resistographs, to evaluate whether wood is decayed.

Figure 38—These tools, plus a camera, a pencil, a knife, a hammer, pry bars, pliers, vice grips, a crescent wrench, a screwdriver, and an awl are needed to perform a condition and historic assessment of a cabin.

Log cabins are more complex than they appear. The following inspection tips may help you perform a more effective condition and historical log cabin survey. If you hire someone to do the survey, the tips will help you understand and evaluate the survey report produced by the assessor.

Foundation Inspection

The foundation is critical to the condition of a cabin because foundation-related problems can lead to problems in other parts of the building. Foundation settling is typical of log cabins. If settlement isn't severe and is no longer occurring, it isn't necessarily a problem. If settlement is active or uneven, or if it is shifting structural weight to unintended bearing points (away from the corners or unevenly distributed on the sill logs), serious wall deflections may occur. Foundations may settle because of decay, subsidence, or undermining. When frost heaves pilings, sleepers, sills, foundations, or chimneys, settlement may occur over many years as the ice melts each spring.

Water is the most common cause of deterioration and damage to any building. Check for water damage that has already occurred or that is likely to occur. At the bottom of the cabin, flowing or standing water can erode the ground beneath foundations or cause the ground to shift or sink (figure 39), making the building sag. Check the drainage around the cabin. The ground should slope away from the cabin (figure 40) so that water coming off the roof, downspouts, or adjacent higher ground won't flow toward the cabin or pool against or beneath it.

High or low spots in the floor, sloping floors, doors or windows that have gaps or that don't close or open properly, cracks or gaps in walls or at corners, or sagging or raised sections of the roof may be evidence of shifting foundations. If the building has a crawl space, root cellar, or basement, inspect the inside of the foundation as well as the exterior. Be safe. Before entering, use a flashlight or spotlight to check your intended path for animals, insects, and potentially hazardous or sharp-edged materials.

Look for evidence of repairs and renovation. New concrete, sawn lumber, and mismatched rockwork or logs are clues that someone may have performed repairs or renovation.

Figure 39—A diverted stream that overflowed and reclaimed its original streambed undermined the foundation of the Adams Ranger's House (Salmon River Ranger District, Nez Perce National Forest, Northern Region). Because the building wasn't in use and funding was unavailable, no one repaired the foundation damage for about 40 years. During that time, the lack of foundation support led to damage to sill logs and other parts of the cabin.

Figure 40—The ground should always slope away from the building, as shown in this photo of the 1931 Indian Creek Warehouse/Shop, so that runoff water is directed away from the structure. The building was moved from the Salmon River Guard Station to the Indian Creek Guard Station (both in the Boise National Forest of the Intermountain Region) in 1968.

Floor Inspection

Check for humps, dips, and sloping floors that could indicate foundation or floor joist problems. Sections of the floor that sink or move when stepped on usually indicate failing floor joists or supports. Joists that weren't designed to support the loads currently on the floor (appliances, fixtures, furnishings, cabinetry, etc.) or rotting flooring or subflooring also are common reasons for these symptoms. Look for stains on the floor that could indicate water damage or spilled gas or oil (these stains most likely will smell like the spilled product). Inspect thoroughly in and beneath kitchens and bathrooms; water leaks commonly cause floor rot in these areas.

Look for evidence of repairs and renovation. Modern flooring materials, plugged or open holes in the floor, mismatched wood flooring, and wood flooring end joints in a straight line rather than in a staggered pattern are clues that someone may have performed repairs or renovations. "Ghosts" (materials that are aged or darkened more or less than their surroundings or have different finish coatings) may indicate the former location of a wall, cabinet, wood stove (figure 41), or stairs.

Log and Wall Inspection

Sill, spandrel, and floor-joist logs usually are the most susceptible components to rot and damage resulting from foundation problems. These logs are crucial to the integrity of the cabin. Unfortunately, they also are closest to vegetation and the ground, both of which harbor wood-destroying moisture and insects. Rain and mud bouncing off the ground are likely to splash these components. In cold climates, winter snow buries sill and spandrel logs and melts against them in the spring. Even rot-resistant logs that are in contact with the ground probably are rotting (figure 42), or soon will rot if the contact with the ground isn't corrected. List the condition of each log in the building assessment notes and identify the probable sources of problems.

Throughout the structure, persistent dampness leads to rot in logs, lumber, paper, and many other building materials. Moss, mold, and mildew indicate excess moisture, but may not indicate structural damage. Conversely, some deteriorated materials don't show these indicators. For instance, multiple coats of paint on a window sill may hide dry, crumbling wood. The

Figure 41—This section of floor at the Adams Ranger's House (Salmon River Ranger District, Nez Perce National Forest, Northern Region) shows evidence of the former location of a stove and also a piece of flooring that someone replaced.

Figure 42—Constant contact with the ground has seriously decayed the sill log of this building.

logs around windowsills and doorsills, corner notches, crown ends, and any other areas that are regularly saturated by rain runoff or backsplash are likely to deteriorate.

Crown ends that extend beyond the drip line of the roof edge are particularly vulnerable to saturation from roof runoff and are a likely spot for rot (figure 43). Flat notching is especially susceptible to rot because the top surface of the log is cut and provides a flat or cupped surface that can hold moisture.

If the site is irrigated, check the sprinkler spray patterns and adjust the sprinkler heads as necessary to ensure that water doesn't hit the building. Outside face rot commonly occurs when vegetation or snow holds moisture against the outside of a cabin or a sprinkler waters the cabin logs regularly.

Vegetation growing beside or on a building may hold moisture against the wood and cause rot (figure 44). Tendrils of climbing vines erode chinking, daubing, and mortar. Specifically designed sod or "green" roofs or walls won't damage a building, but other plants growing on or against buildings eventually will cause damage.

If historic exterior siding covers the cabin, do not rip it apart to test the logs. Generally, don't disturb historic siding unless you see obvious signs of settling or deterioration, or you have reason to believe that the logs behind the siding may be deteriorating. You usually can conduct an inspection where siding is missing, loose, rotting, or damaged, which is exactly where the logs beneath are most likely to have problems. If you must remove pieces of siding to inspect logs, remove them carefully, label them, and save them to reinstall or as samples for choosing or crafting replacement siding.

To detect decay, thoroughly inspect outside, inside, and even beneath the building if it has a crawl space or basement. Carefully probe the logs for rot. If possible, avoid damaging the wood during your investigation because repair techniques can sometimes save even badly deteriorated logs that are mostly intact. Use an awl or narrow knife blade to poke the logs. If you can poke the awl or blade into the log fairly easily, the log is rotten directly beneath the surface. Probe soft areas to determine the depth of decay. Experienced inspectors can reliably detect hollow-sounding areas of possible interior decay by gently tapping up and down the lengths of the logs at regular intervals with a smooth-faced hammer or an awl

Figure 43—The crown ends to the left of center in this photo originally extended beyond the drip edge of the roof. When they began to rot, someone used a chain saw to trim off the rotted ends. They originally looked like the crown ends to the right of center in the photo. Trimming with a chain saw is **not** a recommended "repair" method because it destroys the defining visual characteristics of the building.

Figure 44—Plants that grow on or against buildings, including vines like these, are picturesque, but contribute to log rot because they hold water against the wood.

or knife handle. If you find or suspect rot near the center of a log, you may need to have a structural engineer investigate more thoroughly using stress-wave timing equipment or a drill resistograph.

Long cracks that run with the wood grain (called "checks") aren't signs of rot. They occur naturally as the logs dry out and age. Moisture and fungal decay can get inside a log through a check, however, especially if it is on the log's upper surface. Probe checks to determine whether decay is underway inside the log.

Insect infestation is common in wood construction in many parts of the country. Insects, such as termites, carpenter ants, and powderpost beetles, are more likely to infest logs or other wood that touches the ground or is less than 8 inches above the ground because they can get at it easily and because it is likely to be damp. Look for telltale signs of insect activity, such as mud tunnels, exit holes, or "frass," a sawdust-like powder. Hire a professionally licensed exterminator to treat insect infestations because most of the chemicals that kill wood-destroying insects and deter reinfestation are toxic. For information on wood-destroying insects, see the University of Florida's web page about wood-destroying insects at <http://www.edis.ifas.ufl.edu/IN035>.

Rodents search aggressively for food and dry places to nest. They particularly like to get into uninhabited buildings, and they can wiggle though tiny holes to do so. Evidence of rodent infestation includes their droppings, chewed food containers and fabrics, and nesting sites. Because rodents can carry hantavirus, take proper precautions as identified in the Safety First section of this guide. Keep rodents out by closing up all possible entry holes—which means any opening that a ¼-inch diameter sphere could slip through. For more information about hantavirus and keeping rodents out of buildings, see the Forest Service Facilities Toolbox section on hantavirus at <http://www.fs.fed.us/eng/toolbox/haz/hanta.htm>.

Check for plumb walls using a plumb bob hung on a string attached at the head end of a long nail driven lightly near the top of the wall. If the distance between the wall and string is about the same from top to bottom (allowing for the roundness of the logs), the wall probably is close to plumb. If the plumb bob rests against the wall, it may mean the wall is plumb but the nail is too short, or it may mean the wall is leaning away from you. Try it again on the other side of the wall to confirm. If the plumb bob hangs away from the wall at the bottom (figure 45), the top of the wall is leaning toward you. Check several locations along the length of each wall.

While inspecting the walls, check for loose or missing chinking and daubing, poorly fitting additions, sagging porches, failed or failing connections or notching at the corners, etc. Keep in mind that foundation problems may result in wall deflections and broken connections.

Check the doors and windows to see if the frames are plumb and level and if they open and close correctly.

Look for evidence of repairs and renovation. Joints in the middle of logs (see figure 36), modern dimensioned lumber (figure 46), logs shaped with powertools, inconsistent log species or sizes, corner styles that don't match, and mismatched or modern-looking windows (figure 47), doors, and daubing are clues that someone performed a repair or renovation.

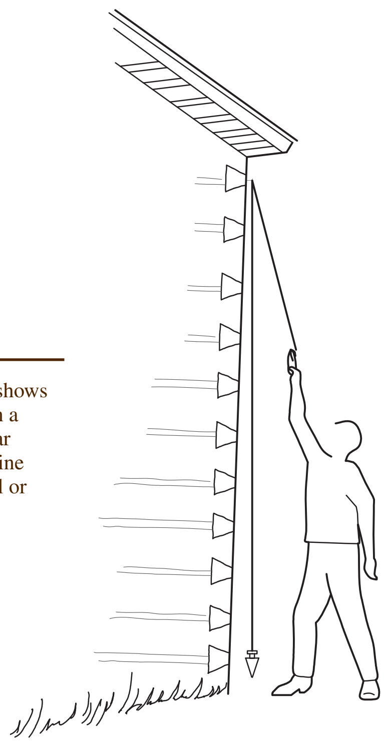


Figure 45—This drawing shows how to use a plumb bob on a string hung from a nail near the top of a wall to determine whether the wall is vertical or leaning.

Figure 46—This building shows evidence of several inappropriate "repairs." The piers supporting the building are of different types of brick and were constructed using at least three different construction methods. Someone used modern dimensioned lumber to replace the sill and spandrel logs. The door may originally have been located where a log "patch" is placed under what is now a shuttered window. People used at least two different styles and materials for the daubing. Someone also used daubing material to "patch" deteriorated areas on the ends of some of the logs.

Figure 47—The single-hung windows in this cabin are newer than the rest of the cabin. Telltale evidence includes the window manufacturing style and the double log trim above the windows. Someone probably used the double trim to mask the gap between the shorter new windows and the logs that were cut for the taller original windows. These changes are typical of evidence that you may find in a structure that is relatively well cared for.

Roof Inspection

Roofs are crucial to the integrity of any building because the roof's primary function is to keep moisture out of the building. Sometimes preservation projects take several years because of the timing or availability of funding or a lack of skilled people to do the work. When beginning such a preservation project, first ensure that the roof isn't leaking. You can temporarily use a tarp to cover a leaking roof if you must complete other work, such as leveling the building, before you can start permanent roof repairs. Remember that a tarp is only a temporary solution. Tarps don't let rain in, but they also don't let water from damp materials out. They can trap water against the structure, which can cause more rot and decay.

Roof Anatomy

From top to bottom, the roof system consists of:

- **Roofing—**Usually wood shingles or shakes, asphalt rolled roofing, or metal sheets.
    - For some cabins: asphalt building paper and metal flashing.
- **Solid sheathing, skip sheathing, or roof lath strips—**For rafter or truss roofs.
- **Framing structure—**Rafters, purlins, trusses, and beams.
- **The top wall log—**Sometimes referred to as the "roof plate" or "rafter plate."
- **Gutters and downspouts—**For some cabins.

Check from both the exterior and interior of the cabin for leaks and damage. Thoroughly check around changes in roof pitch, valleys, ridges, eaves, vents, chimneys, and flues; these areas are especially prone to leaking and deterioration. Check for rot, ridge damage, sagging rafters, broken rafter or collar ties and braces, and framing members that have been dislodged from their sockets in the roof plate or that are cracked. Decay is common on rafter and purlin ends, especially those that extend beyond the roof dripline, as is frequent on rustic-style cabins (figure 48).

Details are important, especially on roofs, because they have such a large affect on the appearance of a cabin. For instance, if historic cedar shingles still are in place, remove several of them and measure their size, shape, exposure length, butt thickness, taper, and any special features. Measure the unweathered portions of the shingles for better accuracy. If someone replaced the original shingles, look for old photos or patterns on the sheathing that might provide evidence about the historic shingles. Peel up a corner of the existing roof covering and check for nail patterns and remnants of the original roof. Examine the original shingles to determine the tree species, such as white oak, cypress, eastern white pine, or western red cedar. Determine whether the shingles are sawn, handsplit, dressed, or beveled. Note any distinctive shaping. Record the materials and layering of the hips, ridges, valleys, and dormers. Photograph and describe any decorative elements, such as trimmed butts, patterns, colored stains or paints, and exposed nails. Note whether shingle lath, skip sheathing, continuous sheathing, or purlins support the shingles. Also note the ridge cap style and whether it appears to be original to the building.

Figure 48—The awl stuck into this rafter tail shows how deeply the rot has penetrated. Rot is very common on rafter tails like these that extend beyond the edge of the roof.

The builders may have used lead as flashing around chimneys or vents in the roof. Although lead is an excellent flashing material that builders still use today, it can be absorbed through the skin and cause serious health problems. Information on how to work safely with lead is available in the Forest Service Facilities Toolbox section on lead roofing and flashing at <http://www.fs.fed.us/eng/toolbox/haz/haz22.htm>.

Few people constructed cabins with gutters, but they sometimes added gutters later. If the cabin has gutters, check whether they are leaking, clogged, or have pulled away from the fascia. Check whether the downspouts leak, are securely fastened to the side of the building, and have returns at the bottoms that direct water away from the foundation.

Look for evidence of repairs, renovation, and former framing, sheathing, or roof materials. Sometimes the top layer hides several layers of previous roof materials. The owner may have raised the roof when adding a second story or made structural changes when constructing an addition. A builder may have framed the roof using material recycled from other buildings, or reused material from an original section of the cabin on an addition. Someone may have repaired the roof after a storm or fire damage.

The Rest of the Cabin

Although most serious structural damage is likely to be in the foundation, floor, perimeter walls, and roof, you may find serious problems elsewhere in the cabin. People often made repairs and renovations to the interior of the cabin as well. Inspect chimneys, fireplaces, stoves, vents, porches, interior walls, trim, plumbing, wiring, fixtures, and finishes for past changes or damage.

Deterioration may simply be the natural result of aging materials. For instance, Bakelite, an early plastic invented in 1909, becomes brittle as it ages and may crumble without ever being damaged. Other deterioration may be the result of poor construction methods or may be because of problems that are telegraphed from other parts of the cabin. Deformed or misshapen window trim may result from a sag or twist in the cabin due to a failed sill log, for example.

If the cabin has painted surfaces (figure 49), the paint may contain lead. Lead was a common ingredient in paint before 1978. If the paint is intact and the cabin won't be used as housing or by children, the lead paint may not be a problem. If you intend to remove, sand, drill, or cut the painted material as part of the renovation, follow the specific requirements for working with lead-based paint that were enacted to protect the health of workers and building occupants. See the Safety First section of this guide for more information about lead-based paint and the requirements for working with buildings that contain lead-based paint.

When inspecting interior trims, paints, and finishes, you may have to gently peel and sand through several layers of paint, flooring, or wallpaper to find the original color or materials. Do so in an inconspicuous place, such as a closet, behind an electrical outlet plate, behind door or window trim, or under a doorsill.

As with the cabin exterior, moisture damage can cause serious decay inside a cabin. If the building contains plumbing, check for pipe, fixture, and faucet leaks. Look for old drainpipes, fixtures, and soldered plumbing joints made of or containing lead. More information on lead and working with lead plumbing is available in the lead and copper plumbing section of the Forest Service Facilities Toolbox at <http://www.fs.fed.us/eng/toolbox/haz/haz30.htm>.

Check for damaged or deteriorated wiring, gas tubing, fixtures, and appliances. Look for fixtures or appliances that don't work, leaking or kinked tubing, tubing in contact with the ground, wiring with brittle plastic or fabric insulation, loose wiring or tubing connections, exposed wires, and broken switches, outlets, valves, switch plates, and outlet covers.

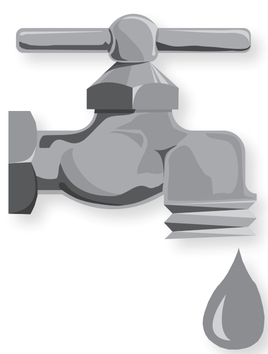


Figure 49—Someone painted the interior of this cabin to provide a brighter and more finished appearance. Test old cabin paint for the presence of lead if you will remove, sand, drill, or cut it during the renovation. If the paint contains lead, you must follow Occupational Safety and Health Administration requirements. *Photo © Andrew Gulliford; used with permission.*

Asbestos was a common component of many building materials from about 1905 to about 1980. Materials containing asbestos may be present in log cabins built or modified during this time period. If you haven't already inspected your building and it contains ceiling tiles, composition flooring, plumbing or boiler insulation, asbestos cement siding, vermiculite insulation, heat-resistant panels or fabrics, caulk, mortar, or adhesives that were installed between 1905 and 1980, hire an accredited asbestos inspector to sample and test the material. Exposure to asbestos fibers or dust can have serious long-term health consequences. For information about materials containing asbestos in buildings, see the Safety First section of this guide. If the inspection report identifies materials containing asbestos or you suspect that the cabin may contain asbestos, do not disturb it. Arrange for properly trained and certified personnel or contractors to perform abatement work on asbestos-containing materials.

Decisions, Decisions: Deciding What To Do to the Cabin

After you have thoroughly inspected the cabin, you must determine what preservation work you should do. When making decisions, consider the historic value of the components. You should repair or replace portions of the cabin that are historically significant with in-kind materials. Portions that aren't significant are better candidates for removal or alteration than historically significant components.

Concerns about obvious structural problems often cause line officers to initiate preservation projects, but many other repairs usually are needed. Now, you must prioritize repairs and decide how far your budget will take you.

It can be tempting to first do those repairs that will make the cabin more attractive. Don't give in to temptation. First, complete the practical repairs that will protect the building from further deterioration—it will be cheaper in the long run. If the inspection reveals any components in danger of imminent collapse, shore them up. If there are problems in the foundation or the roof (figure 50), fix them. Next, close the gaps where weather or animals can enter the cabin. Closing gaps can be a temporary fix, such as putting plywood over a broken windowpane, if time or the budget won't allow permanent fixes right away. Then, concentrate on other structural repairs, such as sill logs, floor joists, walls, ceilings, windows, and doors. You must often perform electrical, plumbing, and heating system repairs in coordination with wall, ceiling, and floor work. Finally, make the cosmetic repairs—paint, floor refinishing, curtains, appliances, fixtures, and so on.

You must decide what methods to use to accomplish the necessary repairs. For instance, if only a portion of a log is rotten, should you replace the entire log, or will a Dutchman splice on the end suffice? Should you repair deteriorated windows or will you need to replace them? See the individual building component sections for information you must consider when making these decisions.

Sustainability is a big concern these days. Although sustainability improvements aren't required for existing Forest Service buildings that are less than 10,000 square feet,

Figure 50—Roofing replacement often is the first renovation chore on a log cabin. These National Park Service preservation workers are replacing the shingle roof on the Jessie Elliott Ranger Station of the Custer National Forest. It's not a log building—it's the only stone ranger station in the Northern Region. The builders constructed it around 1913 and installed wood shingles in the same manner as on log buildings of the same vintage. Full scaffolding with railings all around the roof provided fall protection on this project.

preserving a historic building and keeping it in good repair contributes toward the agency's overall sustainability. Preserving a building for continued use is the ultimate recycling project. Excellent information about historic buildings and sustainability is available from the Whole Building Design Guide web page <http://www.wbdg.org/resources/sustainable_hp.php>, from the National Trust for Historic Preservation website <http://www.preservationnation.org/information-center/sustainable-communities/>, and from the Forest Service Facilities Toolbox section on historic facilities <http://www.fs.fed.us/eng/toolbox/his/susbuildings.htm>, so it's not repeated here.

The first Guiding Principle for Historic Preservation is to retain as much historic and existing fabric as possible. Stabilizing and repairing parts of the building that are only partially damaged by decay or insects are always preferable to replacing these parts. Repairing rather than replacing preserves more of the building's integrity, including historic tool marks. Integrity includes keeping the original components or replacing them with new components that are the same size, configuration, and material as the originals. It isn't always easy to assess how much of the historic fabric you can save without compromising the strength or security of the structure. Generally, if more than half of a log is rotted, replace it. When in doubt, consult a specialist, such as an experienced preservation carpenter, an architectural historian experienced in preservation, or a structural engineer with experience working on historic buildings.

General guidance on repair and replacement decisions is available through the U.S. Department of the Interior, National Park Service's Technical Preservation Services website <http://www.nps.gov/tps/index.htm>, including pamphlets, books, videos, web pages, technical consultation, and education on preserving, restoring, and rehabilitating historic buildings. The National Park Service's Preservation Briefs <http://www.nps.gov/tps/how-to-preserve/briefs.htm> provide information about many historic building materials.

After carefully considering all the factors, outline a preservation strategy that includes the methods you will use in each repair and the order in which you will make repairs.

Negotiating Conflicting Requirements

Sometimes it seems as though there's no way to reconcile preservation requirements with accessibility requirements and building codes. Although historic preservation standards tend to trump other considerations for buildings that have a primary purpose of displaying and interpreting historic resources, most Forest Service log cabins have a primary purpose as an office, residence, or recreation accommodation. There often is a juggling act between accomplishing the primary service provided by the building and maintaining the historic fabric of the building. Building codes, fire codes, accessibility regulations, and historic preservation standards and guidelines all recognize this.

Accessibility requirements for historic buildings differ between residential, commercial, and public buildings and depend on whether the building is being altered or repaired. Be sure to check the historic building accessibility standards available at <http://www.access-board.gov/guidelines-and-standards/buildings-and-sites>. You usually can provide accessibility without impacting the main façade of a cabin. See the Accessibility section of the National Park Service's introduction to the historic standards and guidelines <http://www.nps.gov/tps/standards/rehabilitation/guidelines/introduction.htm> and the Forest Service Facilities Toolbox section on historic facilities <http://www.fs.fed.us/eng/toolbox/his/index.htm> for more information on how to accomplish both accessibility and preservation.

Building codes and fire codes also vary depending on building age, type, and use. International Code Council standards are available at <http://www.iccsafe.org/content/pages/freeresources.aspx>. National Fire Protection Association (NFPA) standards are available at <http://www.nfpa.org/freeaccess>. See the Accommodate Life Safety and Security Needs section of the Whole Building Design Guide <http://www.wbdg.org/design/accommodate_needs.php> for more information about safety and historic preservation.

An Ounce of Prevention: Project Planning

After you've thoroughly inspected the cabin and determined the scope of the preservation work, you can begin planning your project.

As you plan, remember that the most important rule is to **always work safely.** See the Safety First section of this guide.

The following three rules of thumb can have significant consequences for your project:

1. Preservation projects usually take twice as long and cost twice as much as you thought. Even old buildings that are thoroughly inspected tend to conceal surprises that are discovered during the preservation work.
2. Since at least the mid-1800s, people have used the adage "if anything can go wrong, it will." To avoid the consequences of this adage, be thoroughly prepared for all the problems you can imagine and have a backup plan in case something happens that you didn't imagine could occur.
3. Measure twice and cut once. Be patient, think tasks through, and check your work. If you hurry, you will make mistakes and waste materials and may hurt yourself in the process. A few minutes of thought before starting work will make your whole day better.

Project Timing and Work Crews

If possible, plan construction work for a dry weather season when the temperature is above freezing but below sweltering. There are complications if the weather isn't temperate and dry:

- **Wet—**If it's raining, construction materials will get wet and remain wet as you incorporate them into the building. Even brand new materials that remain wet for a while may swell, become moldy, and decay.
- **Cold—**You will find it more difficult to hang on to and manipulate cold, wet tools and materials. If you excavate when the ground is frozen, anything resting on that soil, such as a foundation, will have an alarming tendency to migrate to other locations or settle when the ground thaws.
- **Heat—**If you must work during hot weather, drink plenty of water and take frequent breaks in the shade. If you feel overheated, stop working.

Of course, you can accomplish work during adverse weather conditions—it just takes longer and often requires special measures to protect the site, materials, and workers. Dry, temperate weather occurs at different times of the year in different parts of the country. If you aren't familiar with the climate at the project site, ask several local people. Climate information you find on the Internet is accurate, but doesn't include local quirks.

Do not try to cram the work into a time period that is too short. Remember to allow more time than you think it will take to accomplish the work, especially if several members of the work crew are inexperienced. For example, consider the following time estimates for one experienced person working alone:

- **Replacing or repairing a log or crown end—** 1 hour to 3 days, depending on size, location in the building, and complexity of the repair or replacement.
- **Nailing by hand to lay 1 square (100 square feet) cedar shingle roof—**1 to 3 days, depending on the complexity of the roof.

Plan to use an adequately sized work crew for the project. Remember that some log cabin materials are large and heavy. Although an experienced person may be tempted to work alone, it is much easier and safer for at least two people to work together. Four to six people is a good size for a cabin restoration crew. Ensure that at least one person on the crew is experienced and capable of explaining the work methods and requirements to the less experienced crewmembers. If the crew will move large logs, ensure that the crew is large enough to safely lift the logs (figure 51). If the crew includes an experienced foreman, construction specialist, roofer, or expert rigger, you probably can get by with a smaller crew.

Figure 51—This crew of six people is adequate to safely move large logs using timber carriers (timber tongs attached to crossbars).

Materials and Cost Estimates

Figuring out what materials you need for preservation projects can be a challenge. Using the historic and condition assessments and keeping the three rules of thumb in mind, make a list of all necessary materials. Include big items, such as logs, shingles, and windows; small items, such as nails and screws in the right sizes and shapes; building paper; adhesives; paint or stain; and disposable tools, such as dropcloths and paint-roller covers. Order any materials that aren't readily available at the local lumberyard well in advance of the planned project work dates. Plan to have transportation available to get all the materials and tools to the worksite ahead of the work dates.

When estimating the project cost, be realistic. Consider these general estimates for supplies:

- **Logs—**Free to $400 each, depending on whether you cut your own trees or purchase the logs from a local logger, sawmill, or log home builder.
- **Lumber—**Free to $10 per 10-foot-long 2 by 4, depending on whether the lumber is standard dimension or rough sawn, treated or not, salvaged from another project, or purchased. Custom-cut lumber that matches historic dimensions costs twice as much as lumber purchased off the shelf.
- **Cedar shingles—**About $200 to $400 per square, depending on grade, length, and availability.

You may be able to obtain free or reduced-cost materials at construction salvage yards; from friends, family members, and coworkers; or from hardware and antique stores, yard sales, loggers, construction companies, log home builders, and sawmills. It may take a long time to locate cheap or free materials, so start looking well in advance of the project start date.

Site Preparation

Before you start to work on a building, look around the site. Find and designate suitable areas for staging, storage, trash, salvage, and parking. If you must prepare some materials before using them in the cabin, designate a work area.

Have sleepers available so you can stack lumber and other materials off the ground in case rainy weather turns everything to mud. Have tarps, ropes, and poles on hand to cover materials and work areas in case of rain and to provide shade if the weather is hot. Have stickers (wooden spacers) ready to use when stacking lumber so that air can circulate and the lumber will stay straight. You can cut stickers from any species of dry, unwarped wood; they usually are ¾ inch thick and about 1¼ inches wide. Ensure that dry storage areas are available for tools.

Most old buildings are surrounded by shrubs and trees that someone may have intentionally planted or that just may have appeared over time. Generally, you should remove shrubs or trees within 3 feet of the building before beginning preservation work. However, if the landscaping has historic value, work with the heritage staff or archaeologist to establish a plan to protect the plants and landscape features or remove them during the work and replace them later.

Safety First

Before you begin actual preservation work, a few words about safety: preservation and construction work can be dangerous, so be careful—after all, you want to be able to enjoy the fruits of your labors. Forest Service workers must follow the precautions in their job hazard analysis (JHA). JHA examples are available to Forest Service employees at the Northern Region Safety and Occupational Health JHA web page <http://fsweb.r1.fs.fed.us/safetyhealth/jha.htm> or the Region 1 Historic Preservation Team website <http://fsweb.r1.fs.fed.us/e/FacilitiesAndEnvironmental/Historic Preservation/safety.htm>.

As you read this guide, you will notice that some of the photos show people who aren't following current safety requirements. The author collected the photos over many years, and some of them are much, much older than the current safety requirements. Always follow the current safety requirements, despite what people did (or did not do) in the past.

Here are a few safety tips from experienced preservation workers:

Personal Safety

- Pay attention. Be aware of yourself, your coworkers, and the jobsite.
- Communicate frequently with other workers.
- Do not work alone.
- Do not wear loose clothing or jewelry. Tie long hair back.
- Lift correctly (with your legs, not your back) and ask for help if you need it.
- Wear personal protective equipment, such as gloves, safety glasses, hearing protection, hardhats, chain saw chaps, and leather boots, as necessary.
- Be aware of the weather.
    - Wear sunscreen and a hat on sunny days.
    - Cover work areas during wet or freezing weather to limit slippery surfaces.
    - Do not operate powertools outdoors or work on roofs during electric storms or high wind conditions.
- Keep your fingers and toes out of places where they might get pinched.
- Know the location of the first aid kit, land line phone, cell phone, and radio, and know the route and method for evacuating an injured person to the nearest hospital or emergency clinic.

Jobsite and Work Area

- Keep a clean and tidy jobsite and work area.
- Avoid tripping hazards—maintain clear walkways.

Structural Issues and Hazards

- Before the project begins, inspect the building for hidden defects, weak points, rotten structural members, rodent and insect infestations, and other hazards. Observe clues of building defects, such as:
  - Bulging, buckling, sagging, or cracked walls, floors, ceilings, windows, and chimneys.
  - Piles of sawdust, evidence of rodents, or moisture problems indicated by mold and rust.
  - Inadequate or missing joists, rafters, beams, columns, and foundations.
- Do not work in areas with evidence of defects or hazards until you mitigate them.
- Bees, wasps, and hornets frequently build nests in and around buildings. Remove the nests and avoid stings.

Hazardous Materials

- **Caution:** Follow your respiratory protection program when you must use a respirator (including an N-95 respirator). Check with your safety officer for more information.
- Do not underestimate the hazards of asbestos.
  - Hire an accredited asbestos inspector to sample and test any material you suspect may contain asbestos.
  - Have an accredited asbestos contractor or Forest Service employee certified in asbestos mitigation (figure 52) remove the materials, if necessary.
  - Information about the safe removal of asbestos is available from the local safety officer, an environmental engineer, or from the Forest Service Facilities Toolbox asbestos web page <http://www.fs.fed.us/eng/toolbox/haz/haz02.htm> and the Occupational Safety and Health Administration (OSHA) asbestos web page <http://www.osha.gov/SLTC/asbestos/index.html>.

Figure 52—This properly attired and certified crew is removing asbestos shingles from a Forest Service building roof in Gunnison, CO. The asbestos shingles were under a newer layer of composition shingles.

- Use proper procedures to avoid health hazards when working around lead materials and lead-based paint.
    - If lead-based paint is in good condition and you won’t disturb it during the preservation work, it may be okay to simply leave it in place.
    - Information about lead building materials, lead-based paint, and the requirements for working with buildings that contain lead-based paint are available from:
        - Your safety officer.
        - An environmental engineer.
        - The lead-based paint section of the Forest Service Facilities Toolbox <http://www.fs.fed.us/eng/toolbox/haz/haz03.htm>.
        - The U.S. Environmental Protection Agency’s (EPA’s) Lead: Renovation, Repair, and Painting Program web page <http://www2.epa.gov/lead/renovation-repair-and-painting-program>.
        - The OSHA lead web page <https://www.osha.gov/SLTC/lead/>.
        - The National Park Service’s Preservation Brief 37, “Appropriate Methods for Reducing Lead-Paint Hazards in Historic Housing” <http://www.nps.gov/tps/how-to-preserve/briefs/37-lead-paint-hazards.htm>.
    - You can purchase lead-based paint check kits and swabs at local hardware stores. Only kits recognized by the EPA are considered reliable and accurate, so check the lead test kit’s certification before you buy <http://www2.epa.gov/lead/epa-recognition-lead-test-kits>.
    - Hiring trained, certified testing professionals is the most reliable way to determine the presence or absence of lead-based paint; they will use either a portable x-ray fluorescence machine or perform lab tests of paint samples.

- Be aware that mold growth is a result of moisture problems.
    - To eliminate mold, first eliminate the moisture problem and dry the area.
    - Most molds aren’t toxic, but may cause or worsen asthma or allergies. To be safe, avoid skin exposure or inhalation.
    - To clean up mold, follow OSHA practices in “A Brief Guide to Mold in the Workplace” <http://www.osha.gov/dts/shib/shib101003.html> or hire a certified contractor to remove it.
    - You may have to replace absorbent materials, such as ceiling tiles (figure 53) and carpet, that become moldy.
    - For more information on mold and mold removal, see:
        - EPA’s “Mold” web page <http://www.epa.gov/mold/moldresources.html>.
        - The Centers for Disease Control and Prevention’s “Mold” web page <http://www.cdc.gov/mold/>.
        - The American Industrial Hygiene Association brochure “The Facts About Mold” web page at <http://www.aiha.org/about-ih/Pages/Facts-About-Mold.aspx>.
        - The OSHA “Safety and Health Topics: Molds” web page <https://www.osha.gov/SLTC/molds/>.

Figure 53—The original fiberboard ceiling tiles shown in this photo (taken before renovation of the living room at the Adams Camp Ranger's House) are moldy and damaged by moisture.

- Hantavirus is more common in Western dry-climate States than in the rest of the United States.
  - Hantavirus is primarily transmitted to humans when they inhale airborne dust from dried rodent droppings (figure 54). About a third to one-half of the people diagnosed with hantavirus pulmonary syndrome die from it, so do not take chances.
  - If you find rodent droppings in a cabin, use proper procedures to clean them out before doing any other work. Prevent reinfestation by screening, covering, or filling all openings more than ¼ inch in diameter.
  - Information about rodent dropping cleanup and hantavirus is available:
    - In the hantavirus section of the Forest Service Facilities Toolbox <http://www.fs.fed.us/eng/toolbox/haz/hanta.htm>.
    - On the National Park Service hantavirus risk reduction web page <http://www.nps.gov/public_health/zed/hanta/hanta_risk_redux.htm>.
    - On the OSHA "Safety and Health Topics: Hantavirus" web page <https://www.osha.gov/SLTC/hantavirus/>.
  - In the Forest Service hantavirus JHA <http://fsweb.r1.fs.fed.us/safetyhealth/jha/osha-h/JHA-hantavirus.doc>. **Note:** Forest Service employees must comply with the hantavirus JHA.
- Information about other hazardous materials that may be present in buildings is available in the Hazardous Substances in Buildings section of the Forest Service Facilities Toolbox <http://www.fs.fed.us/eng/toolbox/haz/index.htm>.

Figure 54—The renovators uncovered this rodent nest studded with droppings when they removed damaged fiberboard wall and ceiling panels at the Adams Camp Ranger's House.

Tool Use

- Learn how to properly operate each tool by reading the tool's manual or by getting instructions from experienced employees.
- Use the right tool for the job. A wrench isn't a good substitute for a hammer, and vice versa.
- Keep tools clean and in good working condition.
- Store tools properly.

Log Work

- Set logs on sawbucks and use log dogs to prevent them from rolling (more information is available in the Selecting and Preparing Logs section of this guide).
- Check each log thoroughly for nails before beginning log work. Use a metal-detecting wand if one is available.
- When using an axe, do not allow other people to stand in the chopping area or within the distance that chopped materials may fly.
- Do not operate a chain saw or crosscut saw unless you have proper training and certification for the work that you need to do. The Chain Saw and Crosscut Saw Training Course is available through your unit's normal training process (course materials are available at <http://fsweb.mtdc.wo.fs.fed.us/php/library_card.php?p_num=0667%202C01>).
    - Read and follow the chain saw operations requirements in Forest Service Health and Safety Code Handbook 6709.11, part 22.48 <http://www.fs.fed.us/im/directives/fsh/6709.11/FSH6709.pdf> (beginning at page 20-47).
    - Wear proper personal protective equipment when operating a chain saw. Maintain a comfortable position and good footing.
    - Start the saw with the chain brake engaged. Do not drop-start a chain saw.
    - Keep track of the people around you. Shut off the saw if they get too close.

Working on Roofs

- Follow OSHA fall protection requirements explained at <https://www.osha.gov/SLTC/fallprotection/index.html>.
- Follow the fall protection requirements in Forest Service Safety Code Handbook 6709.11, part 33, at <http://www.fs.fed.us/im/directives/fsh/6709.11/FSH6709.pdf> (beginning at page 30-12).
- Wear a hardhat.
- Ensure that the railings on your scaffolding are solid to prevent accidental falls.
- Use a guardrail system with curb boards, a safety net system, or personal fall-arrest systems if you are 6 feet or more above either the ground or a lower level of the building, such as a flat porch roof. In practice, this requirement means that you must have fall protection for almost all roofing projects.
- Use roof jacks and planks for sloped roofs, when the next shingle layer is high enough on the roof that you cannot stand on the scaffold and reach your work area.

Confined Spaces

Sometimes, log cabin preservation requires work within a space that isn't designed for continuous occupancy and has a limited or restricted means of egress—a confined space. For instance, cisterns and sewer manholes usually are confined spaces. Some crawl spaces and attics may be confined spaces.

- Have a qualified person evaluate all confined spaces to determine whether you need a permit to work in the space.
- Follow the unit's confined space plan and the applicable confined space procedures in Forest Service Safety Code Handbook 6709.11, part 38.2 <http://www.fs.fed.us/im/directives/fsh/6709.11/FSH6709.pdf> (beginning at page 30-38), to determine whether working in the confined space requires a permit or not.

Lockout and Tag-Out

Log cabin preservation frequently includes work around powered equipment or machines or live electric wiring.

- Follow lockout and tag-out procedures to protect against the hazards of machinery or equipment starting unexpectedly or the release of hazardous energy.
- Understand the lockout and tag-out requirements explained in Forest Service Safety Code Handbook 6709.11, part 38.3 <http://www.fs.fed.us/im/directives/fsh/6709.11/FSH6709.pdf> (beginning at page 30-42), and in your unit's lockout and tag-out plan.

Out of the Mud

You've inspected the cabin, identified the parts you need to preserve, planned the project work, and assembled supplies. Now comes the fun part—the actual preservation work.

Raising and Leveling

Many old cabins sag or rot over time. Your first preservation work is to raise and level the building if it requires a new foundation, foundation repairs, new sill or spandrel logs, or if it's out of plumb, out of level, or out of square. Next, you need to install cribbing so the building won't move while you make repairs.

In this guide, when referring to lumber dimensions, "x" is used in place of the word "by" to indicate the thickness and width of a board. Thus, a nominal 2-inch-thick board (actually about 1½ inches thick) by 4-inch-wide board (actually about 3½ inches wide) is shown as "2x4." This nomenclature is the standard among builders, lumber yards, and sawmills. The nominal dimensions represent the approximate dimensions before the boards are planed smooth.

Supplies Needed To Raise and Level a Building

- Surveying level or professional quality laser level.
- Telescoping survey rod or direct reading grade rod.
- Markerboards (also called "storyboards").
  - Use rulers, 1x4s, or other scrap lumber as markerboards.
- Cribbing (figure 55).
  - Prepare several sizes of solid, unwarped boards and lumber, such as 1x4s, 2x4s, 4x4s, 6x6s, and 8x8s.
  - Cut the wood into 1½- to 2-foot lengths.
- Miner's wedges.
  - Buy or make quality miner's wedges (figure 56) from straight, tight-grained wood—you will hammer them into place, and poor-quality wedges will split and splinter.
- Sledge hammers (figure 56).
  - Larger sledge hammers swung using both hands are sometimes called double jacks. Smaller sledge hammers swung using one hand are called single jacks.
- Framing hammer and other hammers, as desired (figure 57).
- Band clamps (figure 58).
- Assortment of pinchbars, pry bars, and crow-bars (figure 59).

Figure 55—Cribbing requires the use of many different sizes of lumber, as well as wedges.

- Screw jacks and bars.
  - Use only screw jacks (bell-base jacks or house jacks are the most commonly used types) because hydraulic jacks raise a building too fast and can bleed off unexpectedly, which will cause the building to drop suddenly. Screw jacks (figure 60) come in many different sizes, from 4 inches to 2-feet tall.
  - Use rolled steel bars to turn the jack head and steel pipe that fits over the bars as cheater levers.
- Liquid bubble levels: torpedo, 12 inch, 24 inch, and 48 inch.

Figure 56—Large and small sledge hammers and an assortment of miner's wedges are essential tools for jacking and cribbing.

Figure 57—Each hammer in this assortment is best suited for a slightly different purpose.

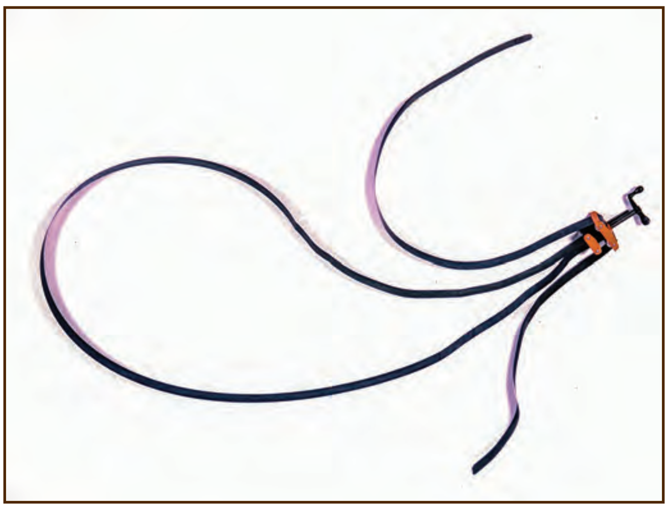


Figure 58—Use band clamps to hold log walls together when the walls are elevated above their foundations.

Figure 59—Bars come in many different configurations, providing shapes appropriate for all sorts of prying tasks.

Figure 60—Screw jacks are available in many sizes, from 4 to 24 inches tall. Place the small plate between the jack head and the log to prevent damage to the log.

First, determine how out-of-level the building is. Set up the surveying level (figure 61) or laser level, and establish a couple of solid reference benchmarks outside the work area. Then, survey the building to determine the high and low points of the building floor or foundation. Be sure to record the measurements and reference them to the benchmarks. Determine which portions of the building you need to adjust and how far you need to move each part. Set up the level far enough away from a corner so that at least two sides of the building are visible. Open the building doors and windows so you can see the far interior wall(s) of the building to track the progress of as much of the building as possible from this location. Because you need to keep the level in one place during the jacking process, set up the level on a tripod or stable base. If you are careful, you can remove the level from the tripod or base each night and replace it in exactly the same place every day. Using a level isn't difficult, but you must use it correctly to obtain good results. To save yourself some headaches if you don't know how to use a surveying level or laser level, or if it's been a while since you used one, enlist the aid of someone who uses the instruments routinely. Information about using levels can be found at <http://www.engineersupply.com/How_to_Use_Berger_Transits_and_Levels.pdf>. Information about using levels and transits is also available at <http://www.askthebuilder.com/using-transits-laser-levels-and-optical-builders-levels/>.

Use markerboards (figure 62) to easily see whether you are jacking up the building evenly. You can make markerboards from rulers, 1x4s, or other scrap lumber. If you're using lumber, mark each board in ½-inch increments and number the increments. Focus the level on the exterior corners, at the mid-wall, and wherever visible on the interior walls. Tack up markerboards in each of these places. Record the number that you see at the horizontal crosshairs. Then, as the building moves, you can see how each corner or portion moves relative to the rest of the building and the ground.

If necessary, brace and stabilize the building. Use band clamps, whalers, interior bracing, or a combination of these methods, depending on the circumstances. Band clamps are metal bands with a tightening mechanism (figure 63) that can

Figure 61—You can use a builder's transit or level to establish high and low points on a building and track jacking progress.

Figure 62—Preservation carpenters attached markerboards (circled) made from 1-inch-thick lumber to the sill logs of the Sage Creek Cabin (Custer National Forest, Northern Region) so they could use a transit to check that the building rose evenly and remained level.

Figure 63—Workers can adjust this band clamp using the tightening screw, which has an offset handle.

encircle a log wall from top to bottom and hold all the logs together (figure 64). Whalers are paired timbers (one board on either side of the wall) that are through-bolted or nailed to each log, creating a log and timber "sandwich" (figure 65) to stabilize the wall. Interior bracing methods include "X" braces, plywood sheeting, and shore posts (figure 66).

Because stabilization won't completely eliminate shifting while you raise the building, you also may want to remove doors and windows or apply electrical tape "Xs" to the windows to improve flexibility and keep the glass in place if it cracks. If the cabin has masonry daubing, expect some of it to crack and fall out—this is normal and is easily repaired.

The following jacking and cribbing process works for raising an entire building or for bringing only a portion of the building back into level with the rest of the structure. If you only need to raise part of the building, you may not need markerboards, but you certainly will need a building level or laser level to track progress and confirm when you achieve leveling.

If you raise the entire building to replace logs or foundations, take the opportunity to level the building, if necessary. The best way to determine what is level on a log cabin is to use the head jambs of doors and windows and the top plate logs as level guides. You will have to use some judgment in determining which of these options you should use as the level guide, or whether a compromise level that doesn't quite match any of them is more reasonable. Remember, log cabins were rarely completely plumb, square, or level when newly built. The goal should be to make the cabin as close to level as it originally was.

After you set the level, place the markerboards, and stabilize the building, you are ready to build jacking and cribbing platforms. Create an access point for each jack and the adjacent cribbing by digging a hole below the log you will lift that is deep enough for the jack and platform. The most efficient method is to set the jack directly under the log wall. If the bottom logs are rotted, cut a hole vertically from the bottom of the wall through any rotted logs up to a sound wall log. If necessary, remove a portion of the foundation to reach the lowest sound log. After you create the access point, use some

Figure 64—Preservation carpenters used band clamps to hold the logs together on the front of this cabin in Nevada City, MT, during a renovation project. Clamping allowed the carpenters to remove the rotten sill logs and to raise the building without risking collapse.

Figure 65—Whaler systems "sandwich" logs between bolted timbers to keep them in place during renovation activities.

Figure 66—The roof of this cabin is temporarily supported by a beam on "X" braced shore posts.

of the 2x cribbing (figure 67) to build a solid, level base for the jack to sit on. If you used whalers to tie the walls together and the whalers are strong enough, you can use them as stable jacking points (figure 68). In this case, excavate the hole for the jack and platform under the whalers, not the wall. Remember, if the jack base isn't solid and level, your building won't rise correctly and the jack could kick out, allowing the whole building to drop.

Figure 67—This jack is set up on level cribbing directly under the log wall.

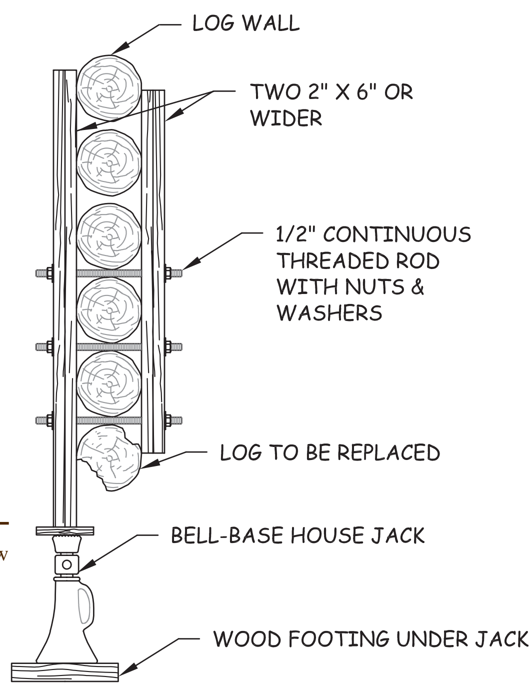


Figure 68—This drawing shows how to use a whaler as a jacking point. Notice that the whaler is shorter on the right side to allow you to easily remove the bottom log.

If the building needs a new foundation but doesn't have full-length or full-width floor joists, you will need to insert supports that extend the full width of the building during the raising and leveling process (figure 69). People often refer to these supports as needles. Needles can be steel beams, heavy timber beams, or built-up wooden beams constructed from three or four 2x8s or 2x10s tied together using cleats or through-bolts (figure 70). If you're using needles, excavate the holes for the jacks and platforms outside the walls, where the ends of the needles will be. Arrange the needles under

Figure 69—Preservation carpenters set up a jack and cribbing outside the log wall of the Sage Creek Cabin (Custer National Forest, Northern Region) to support the laminated wood needle. The needle helped to support the cabin as the carpenters raised it.

Figure 70—This preservation crew is constructing needles to support the Sage Creek Cabin (Custer National Forest, Northern Region) while they raise and replace the sill and spandrel logs.

the building to support all of the building's weight (exterior walls, load bearing interior walls, floor joists, chimney, etc.). You may need to excavate to provide enough clearance between the soil and the building to accommodate the needles. If you need to remove and replace only the lowest log, use a short needle on cribbing (figure 71) and band clamps around the other wall logs to provide solid support for the cabin above the lowest log.

After you build the jack platforms, construct a cribbing platform using 2x material adjacent to each jack (figure 72). You need to adjust the adjacent cribbing as you raise the building so that the cribbing holds the building solidly and steadily between each jacking raise and so that it limits the distance the building could drop if the jack fails during a raise.

Next, set the jacks in place. Begin raising the building slowly, cranking each jack only ¼ inch or one-quarter turn at a time. Check the markerboards frequently and listen and watch for signs of excessive stress, such as cracks in finish materials (don't worry about chinking and daubing) and loud popping and creaking noises. Some minor popping and creaking noises are inevitable, but loud noises can indicate trouble. If you hear or see signs of stress, check that you are raising the building evenly. Adjust as necessary. If signs of stress continue, you may need to back off and crank only ⅛ inch at a time or adjust the placement of the jacks. Keep in mind that jacking is always a slow process, and take all the time you need to minimize stress on the building.

As you raise the building, stop after every ½-inch rise to build up the cribbing. This process is referred to as "chasing the jack." Build the cribbing in a crosshatch pattern for maximum safety and stability (figure 73). You can replace several ½-inch-thick boards with 2xs as the building rises enough to accommodate the thicker boards. Always lay the cribbing plumb and level. Use a torpedo or small bubble level frequently to check the level on the cribbing, bars, and needles (figure 74). Every time you take a break or reset the jack, pound miner's wedges between the top of the cribbing and the bottom of the log to keep everything tightly supported (figure 75).

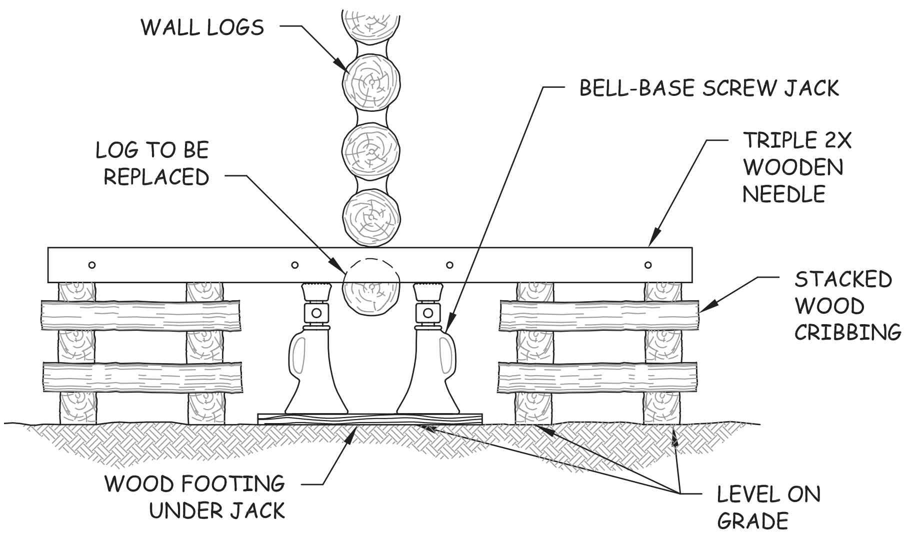


Figure 71—This drawing shows how to set up a jack and cribbing system to support a wall while you remove the bottom log.

Figure 72—Preservation carpenters stacked cribbing in several locations under needles and solid logs to support the Sage Creek Cabin (Custer National Forest, Northern Region) as they raised the cabin using jacks.

Figure 73—This crew at Garnet Ghost Town within the Bureau of Land Management's Garnet Resource Area in Western Montana employed safe cribbing and jacking techniques. They constructed a level, stable base in a crosshatch pattern to support the jacks and cribbing, then stacked the cribbing in a crosshatch pattern.

Figure 74—These crewmembers are using a bubble level to check that the jacks, cribbing, and jacking plates remain level.

Figure 75—This crewmember is pounding in miner's wedges to keep the support tight to the log.

How To Use a Jack To Raise a Building

1. Raise the jack(s) ¼ inch or one-quarter turn at a time.
2. Build up the adjacent cribbing so that it is tight to the structure (you can swap thicker cribbing for several thinner boards, or vice versa) as you raise the building at ½-inch intervals.
3. Check the markerboards and adjust the jacking and cribbing if necessary.
4. Repeat until you reach the jack's limit.
5. Build up the adjacent cribbing so that it is tight to the structure.
6. Remove the jack(s).
7. Rebuild and raise the cribbing beneath the jack(s), leaving only enough clearance to reinstall the jack(s).
8. Reset the jack(s).
9. Raise the jack(s) ¼ inch or one-quarter turn at a time.
10. Build up the adjacent cribbing at ½-inch intervals so that it is tight to the structure.
11. Check the markerboards and adjust the jacking and cribbing if necessary.
12. Repeat until you raise the building as high as necessary (figure 76).

Figure 76—Preservation carpenters raised the Sage Creek Cabin (Custer National Forest, Northern Region) 18 inches during a 2-week period, using needles, jacks, and cribbing.

Foundations and Site Preparation

A building needs a solid foundation to keep it plumb and level, out of the dirt, and ventilated underneath. The foundation should have good drainage, be stable, adequately support the building and its floor loads, and keep the sill logs, spandrel logs, and floor joists a sufficient distance from the ground and moisture to deter decay and insect infestation. Log buildings with cellars are less likely to suffer foundation problems than those built on the ground or with crawl spaces, as long as the cellar remains dry and ventilated.

A good foundation extends the life of any building and is particularly important for historic buildings. Most preservation or restoration projects include foundation work. Although replacement in kind and use of matching materials are the norm for preservation work, some leeway exists for foundations. If the builders originally constructed a building without a foundation or constructed an inadequate foundation, you must build a new or better foundation for the building to survive.

Foundation changes do affect the material and visual integrity of the building, but the tradeoff is a longer life for the building. Keep in mind that the SHPO will probably need to review or approve any changes to the foundation if a Federal or State government agency owns the cabin, or if some Federal or State sources provide some or all of the funding for cabin preservation work. The SHPO usually approves beneficial changes that are in keeping with the character of the building. Check with your heritage resource specialist or archaeologist for the requirements.

People who didn't expect to stay long sometimes constructed cabins on wooden sleepers or log pilings that have rotted (figure 77) because of direct contact with the ground. You will have to lift the building to access and replace the sleepers or pilings, as explained in the Raising and Leveling section of this guide. Unless you require exact replication or the sleepers or pilings will be highly visible when the work is completed, choose the most rot-resistant logs or lumber available for the new sleepers or pilings and set them on concrete footings. Consider replacing log pilings with masonry or stone piers if that type of construction is common for other historic cabins in the surrounding area.

Figure 77—The builders constructed this small cabin on log sleepers laid directly on the ground. Despite the relatively dry climate, the sleepers have almost entirely rotted away, and the sill and spandrel logs have now begun to melt into the dirt also.

Do not replace the entire foundation if the building assessment found only minor foundation problems, such as cracked or missing mortar or loose stones. Simply fix those specific problems. Reset loose stones in their original locations if possible. Mix and apply replacement mortar to match the original mortar as closely as possible. This process may entail trying several combinations of sand, lime, and Portland cement to find a mix that matches the appearance and function of the original. Experiment with test mixes in small batches and compare them side-by-side to assess the best match (figure 78).

The masonry or cement foundations of many log buildings don't extend below the frostline and are susceptible to distortion and settlement caused by ground heaving during freeze-thaw cycles. Repair foundations that have shifted or settled and no longer properly support the building. Replace missing foundation components in kind. If the foundation is decayed, shifted, or damaged beyond repair, rebuild it. Construct new foundations using modern methods, including reinforcing rods and a footing under the stem wall (see figure 5). Ensure that the visible part of the foundation matches the historic appearance. In many cases, you must first level the building and support it on cribbing while repairs are underway, as explained in the Raising and Leveling section of this guide.

Some log buildings have stone-pier foundations (figure 79) or are supported by a row of individual pier stones. If the builders didn't lay the pier stones correctly, the foundation will fail over time.

Support all piers and foundation walls on footings that you set below the frostline. Frost depth or foundation depth usually is specified in local building codes. Building codes may not provide adequate guidance outside municipal areas. For Forest Service projects, check with the facilities engineer to determine the frost depth in the area, which varies not only with soil type and maximum extended low temperatures, but also with precipitation patterns, particularly snow cover. Civil or structural engineers or architects who are familiar with the area also may be able to provide more guidance on frost depth.

Set footings for piers at each corner, spaced along each wall and under each bearing point of the building. If the existing pier stones are undersized, locate larger stones or build new

Figure 78—A preservation crewmember shaped several mortar test mixes into patties and allowed them to cure on a plywood sheet. He compared the mixes side-by-side and moved the whole sheet near the original mortared structure to compare them with the original mortar. When you compare mixes, it is easier to see what adjustments you should make to match the original mortar.

stone piers. For best stability and durability, have a structural or geotechnical engineer design the footings and pier spacing to adequately support the building. For smaller log cabins, concrete footings that are at least 18 inches square and at least 12 inches deep generally will provide adequate support if the frost depth is shallow (figure 80).

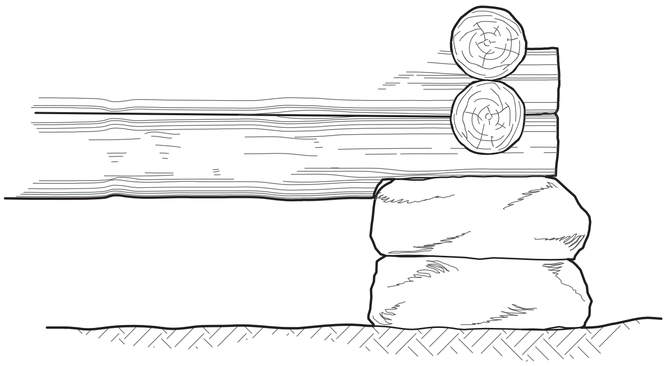


Figure 79—This drawing shows a stone pier constructed of flat rocks supported directly on the ground surface, which is typical of historic log cabins. The sill log is hewn to fit the top of the pier.

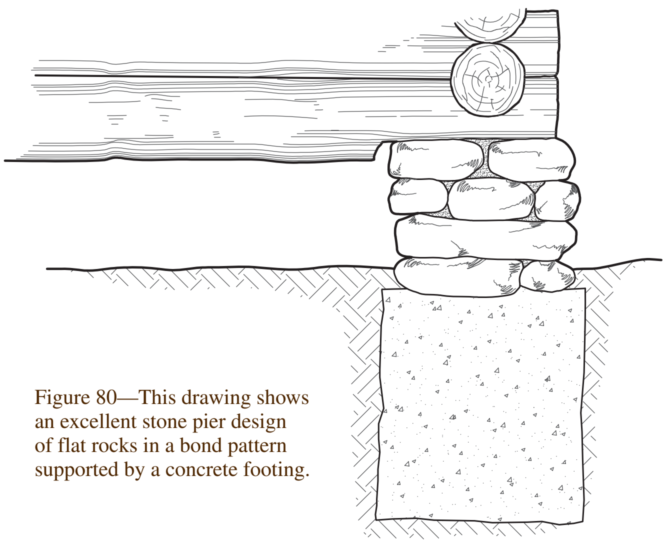


Figure 80—This drawing shows an excellent stone pier design of flat rocks in a bond pattern supported by a concrete footing.

After the concrete footing cures, lay the original pier stones again or construct new piers (figure 81). Construct new piers from the same type of masonry as the original historic piers, whether the masonry is bricks, stones, split rock with mortar, or even concrete blocks. Build the piers as tall as the originals, but at least tall enough so that they provide a minimum of 8 inches of space between the ground and the sill log (figure 82).

You may be able to repair continuous foundations of masonry or concrete if they have only partially failed. Completely replace severely deteriorated foundations (figure 83). Support the building on jacks, bars, and needles (figure 84) and remove all the damaged or failed sections. If the foundation is constructed of masonry, be careful when removing the individual stones or bricks. Salvage and carefully store materials that are undamaged for reuse in the reconstructed foundation.

Continuous foundations usually are composed of a footing and a stem wall, with vents spaced along the wall. If the original foundation was only a stem wall without a footing, add a footing when you reconstruct the foundation. The footing won't change the building's appearance, but it will add stability to the foundation and extend the life of the building. As with pier foundations, have a structural engineer design the footings and stem wall to ensure adequate stability and support for the building. Footings must be below the frostline.

Build the new foundation as tall as the original, but at least tall enough to provide a minimum of 8 inches of space between the ground and sill log. Use materials and workmanship that are similar to the general appearance of the original foundation. Unlike with modern log home construction, do not put foam sill sealer between the foundation and the sill and spandrel logs because in historic log buildings the sealer is more likely to trap moisture against the logs than prevent moisture from wicking into the logs. You may lay a sill plate of treated lumber between the foundation and the sill and spandrel logs to raise them off the foundation and prevent the logs from wicking moisture. If you add a treated lumber sill plate, set it back 1 inch or so from the outer edge of the foundation. For a more historically appropriate appearance, conceal the sill plate by applying daubing over its exterior surface. Use daubing that matches the daubing used between the cabin logs. See the Chinking and Daubing section of this guide for more information.

Figure 81—Preservation crewmembers constructed a new footing and stone pier at the Judith Guard Station of the Lewis and Clark National Forest, Northern Region. The footing is under a corner of the cabin where the wall meets the porch.

Figure 82— A preservation crewmember constructed a new footing and sturdy flat stone pier at the Badger Cabin within the Lewis and Clark National Forest, Northern Region.

Figure 83—This foundation corner is cracked and leans out, but it's more intact than the rest of the foundation under the Bull River Guard Station of the Kootenai National Forest, Northern Region. The forming details in the concrete are important to the appearance of the building.

Figure 84—Preservation crewmembers removed part of the foundation to allow placement of a jack (center) and a timber needle (far right) to support the cabin during foundation removal and log replacement. The crewmembers replaced these temporary supports with steel needles on cribbing before forming the new foundation.

If you've supported the building on needles, construct the new foundation around the needles (figure 85). When the building rests on the new foundation and you remove the needles, transform the gaps in the foundation that you left around the needles into foundation vents (figure 86) or fill them in with the same material as the rest of the foundation. Be sure to provide foundation vents with sufficient open area so that moisture isn't trapped beneath the building. Have an engineer or architect determine the necessary vent square footage. The needle gaps alone may not provide enough venting. Be sure to screen the vents so that rodents and insects can't get under the cabin. Use a layer of insect screen behind a layer of ¼-inch metal hardware cloth. Apply the screening on the inside of the foundation where it won't be noticeable.

Use hardware cloth inside the foundation to keep rodents out if you construct the foundation wall using unmortared rubble, split stone, or cobblestone (figure 87). Before building the aboveground portion of the new foundation wall, measure the height of the gap between the ground and the sill and spandrel logs and add about 1 foot. Cut the hardware cloth to this width. Tack the edge of the hardware cloth to the underside of the sill and spandrel logs all around the foundation so that most of the cloth hangs to the inside of the foundation. Run the cloth down about 6 inches below the ground inside the foundation. Bury the cloth belowground inside the foundation wall. If you cannot excavate to bury the cloth, fold the extra length along the inside of the building and weigh it down flat against the soil with plenty of heavy rocks, then finish building the foundation wall.

An unsupported slab foundation basically is a sheet of concrete laid on the ground that directly supports the log walls. Unsupported slabs don't have a stem wall or thickened edge that extends below the frostline. Do not construct an unsupported slab beneath a log building (or any other building) in an area with expansive soils or a climate that experiences ground frost. The slab will crack and heave. If your cabin rests on a failed, unsupported slab, jack the building up, remove the old slab, and build a new continuous foundation that extends below the frostline to good bearing soil. In some cases, you may be able to remove only the outer edge of the slab and replace it with a proper foundation to support the log walls. You can leave the remainder of the slab in place as a floor. Replacing the slab is an enormous amount of work, but will save the building.

Figure 85—Preservation crewmembers replaced deteriorated logs and constructed forming for the new foundation around the steel beam needles that support this cabin.

Figure 86—The completed replacement foundation matches the appearance of the original foundation, including the forming details on the corners. Preservation crewmembers created foundation vents out of the gaps in the foundation through which the steel beam needles extended.

Figure 87—Preservation crewmembers constructed a new cobblestone foundation under the Cooper's Flat Cabin in the Bitterroot National Forest, Northern Region.

Log Replacement

Because the steps for repairing and replacing logs are more interwoven than sequential, and many choices and options exist, it is difficult to present the information in logical order. This section will first explain how to select and prepare logs, then how to remove and replace logs, how to shape logs, and finally, how to repair logs.

Selecting and Preparing Logs

People usually think of historic cabin logs as being round, but they actually were often sawn or hewn (figure 88), especially where larger logs were available. Builders normally constructed a cabin with only one log shape, but sometimes incorporated a different log shape for additions or other changes to the building.

Although builders frequently constructed log cabins using only a felling axe, a broadaxe, and a saw, nowadays builders commonly use a large kit of handtools and powertools.

Basic Toolkit for Log Work

- **Measuring tools—**Calipers (figure 89) and tape measures (figure 90).
- **Moving and carrying tools—**Timber tongs, hooks, and big mallets (sometimes called commanders, commandettes, beetle mallets, or persuaders) (figure 91).
- **Debarking tools—**Bark spuds (figure 92), spokeshaves, and drawknives (figure 93), and sometimes shovels.
- **Holding tools—**Log dogs, log staples, and log cleats (figure 94).
- **Log shaping and working tools—**Chain saws; axes and hatchets (figure 95); broadaxes (figure 96); adzes (figure 97); smooth-faced hammers; chisels, slicks, and gouges (figures 98 and 99); crosscut saws and handsaws (figure 100); and circular saws, worm drive saws, and reciprocating saws (figure 101).

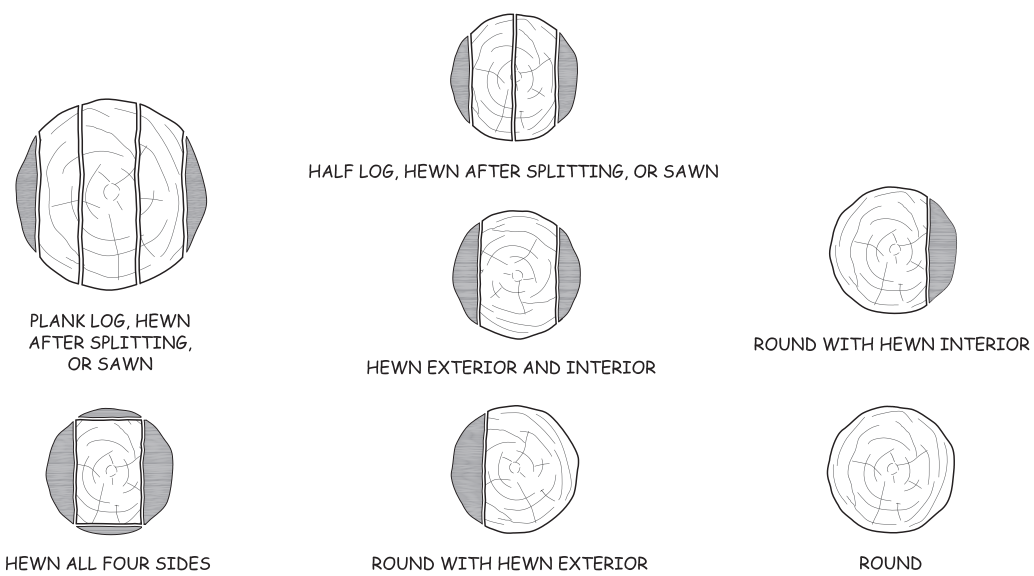


Figure 88—This drawing shows the various shapes used for cabin logs. Logs that are hewn or sawn flat on only one or two sides are called “cants.” The sections of log that are sliced or split from the outside of hewn logs sometimes are called “slabs.”

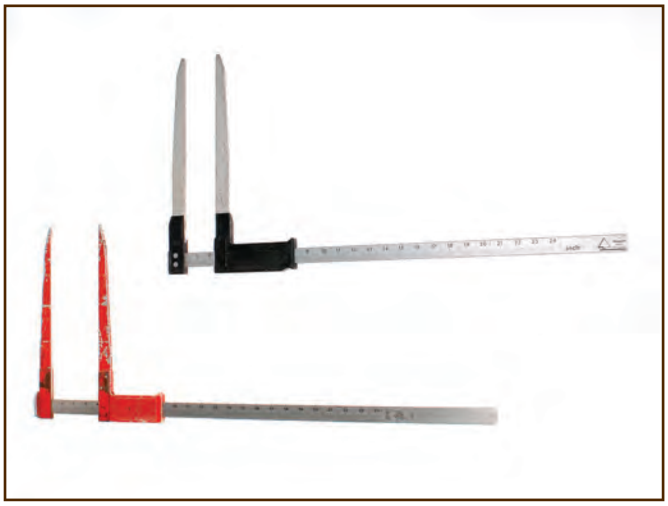


Figure 89—The Northern Region Historic Preservation Team uses an assortment of log calipers.

Figure 92—From left to right, these tools are a hardwood bark spud specially made in a shop, a Snow & Nealley bark spud, and a Dixie cedar bark spud.

Figure 90—It's handy to have an assortment of measuring sticks and tapes available for use during log cabin restoration projects.

Figure 93—You can find drawknives and spokeshaves in various configurations and sizes. This photo shows two spokeshaves (at the bottom) and a variety of drawknives. Both drawknives and spokeshaves smooth wood as the operator pulls them across the wood surface.

Figure 91—From top to bottom, these useful log handling tools are timber tongs on a carrying bar (sometimes called a Swede hook), an old style cant hook, a peavey, a short-handled cant hook, railroad tie tongs (to the right), a hookaroon, a pickaroon, a hickory-head commander mallet with iron bands (to the right), and a homemade Osage orange-head commander mallet.

Figure 94—You can find log dogs (on the left, sometimes called log staples) in various sizes with either chisel or pointed ends. The most effective chisel end log dogs are constructed with the flat side on one end perpendicular to the flat side on the other end. Log cleats (on the right) come in pairs connected by ropes.

Figure 96—From top to bottom, these three tools are a Gränsfors Bruks 4-pound, 1700 pattern Swedish broad axe with a 17-inch handle; a Beatty 9-pound Pennsylvania pattern broad axe with a 20-inch single bit handle; and a Douglas 8-pound New Orleans pattern broad axe with a 20-inch dog leg (sideways bend) handle.

Figure 95—You can find axes and hatchets in a variety of configurations and sizes. This assortment includes, from left to right, a True Temper 5-pound single bit miner's pattern axe with a 28-inch handle, a True Temper 3½-pound single bit Jersey pattern axe with a 32-inch handle, a Hy-Test 6-pound single bit Australian pattern axe with a 32-inch handle, a Bluegrass 3½-pound double bit western pattern axe with a 32-inch handle, a 2½-pound double bit axe with a 24-inch handle, a 2½-pound single bit boy's axe with a 20-inch plumb handle, and a Gränsfors Bruks 1½-pound carpenter's hatchet with an 18-inch handle.

Figure 97—From left to right are a Douglas carpenter's adz, an Austrian hatchet adz, an enxó hand adz from Portugal, and a Cheney adz-claw hammer.

Figure 98—You can safely transport assorted chisels and gouges in handmade leather tool rolls such as these. You will need a few handy mallets to operate the chisels and gouges.

Figure 99—From left to right, these tools are two antique 3½-inch slick chisels, a Barr 3½-inch scarf slick chisel, a Barr 2½-inch gouge, and an antique swan neck chisel.

Figure 100—From top to bottom, these saws are a one-man crosscut saw with Great American tooth pattern and its wooden sheath, a Disston champion tooth pattern pruning saw with its leather sheath, and a 4-foot Royal Chinook lance tooth pattern convertible one-man/two-man crosscut saw with its fire hose sheath.

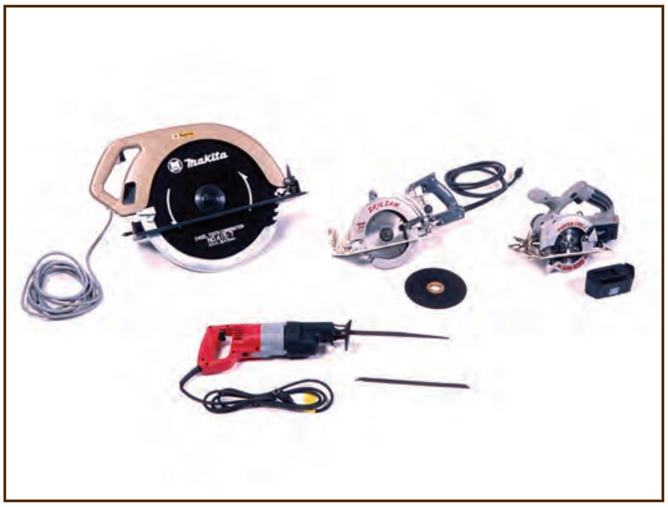


Figure 101—The powertools in the top row are a 16¼-inch diameter Makita circular saw, a 7¼-inch diameter Skilsaw worm drive circular saw, and a 6-inch diameter Porter-Cable cordless circular saw with an extra battery and battery charger. Below the three circular saws is a Milwaukee Sawzall reciprocating saw with blades for cutting wood and metal.

Additional Tools for Log Repair and Replacement Work

- Hand planes (figure 102) and power planes.
- Power drills, bits, and hole saws (figure 103), hand drills, and augers.
- Squares and short lengths of steel bands (figure 104) or asphalt building paper strips.
- Scribes (figure 105).
- Levels, plumb bobs, and stringlines (figure 106).
- Sanders, routers, power planers, and grinders (figure 107).
- Graphite or blue lead pencils and blue chalk. ONLY use pencils or blue chalk; felt-tip markers or red chalk won't wear off and will bleed through paint and stain (figure 108).
- Epoxies (figure 109).
- A generator for powertools if electricity isn't available onsite.

The brand names mentioned in the figure captions are for identification purposes only and are not a recommendation or endorsement of those products. See Appendix F—Acquiring Tools and Materials for more information about where to obtain tools.

Figure 102—The planes in the left column of this photo are,from top to bottom: an old Stanley #5 corrugated blade jack plane with a plane angle guide, a Lie-Nielsen scrub plane, and a large Veritas low-angle rabbet block plane. On the right, from top to bottom, the planes are: an old Stanley #3 finish plane, a Stanley #78 rabbet plane, and a Lie-Nielsen rabbet block plane.

Figure 103—These three tools are, from top to bottom, a Milwaukee Hole Hog with a 24-inch-long, ¾-inch bit and a 24-inch bit extension; a Porter-Cable 19.2-volt, ½-inch chuck cordless drill with a ¼-inch Irwin bit; and a Milwaukee ½-inch hammer drill with a "D" handle and a 1¼-inch diamond masonry bit. Also shown are a 2½-inch carbide spur cutter bit and a Milwaukee hole saw kit.

Figure 104—At the top of this photo is a steel band for marking round logs. Other layout and measuring tools on the left are, from top to bottom: a large framing square, a small framing square, a large wood handled tri square, and a sliding “T” bevel. On the right are, from top to bottom: a caliper made from two small squares, a protractor with an extension arm, and an angle divider. A sliding “T” bevel is an adjustable gauge for setting and transferring angles. An angle divider divides the miter angle of inside or outside corners so that trim or other components can be cut properly to fit into odd angles.

Figure 105—This assortment of scribes includes, counter-clockwise from the left: a Veritas transfer scribe, a Starrett transfer scribe with a separate angled pencil attachment, two old divider scribes, and two different Gränsfors Bruks forged log scribe models.

Figure 106—This photo shows some older model plumb bobs and levels, but the newer versions are very similar, although with more plastic parts. Shown are, from top to bottom: a 24-inch-long Stanley wooden level, a wooden torpedo level, a stringline level, a small square with a clamp-on level attached to it, a brass plumb bob, and an iron plumb bob.

Figure 107—This group of planers, sanders, and grinders includes a 3¼-horsepower, 5-speed Porter-Cable plunge router (top left), a 4-inch Makita belt sander with dust bag (lower left), a 6⅛-inch Makita planer (upper right), a 3¼-inch Makita planer (middle right), and a Bosch 4½-inch disc grinder with a wood planing disc and a 4½-inch carbide metal wood rasp disc (bottom right).

Figure 108—Use pencils and blue chalk (as shown in this photo) on logs, not markers or red chalk. Marker ink and red chalk will not wear off and will bleed through paint and stain. The pencils in the upper right of the photo are blue ink pencils—when you spray the pencil line with water, the line turns blue. Blue lines are easier to see on logs than are graphite lines.

Figure 109—Epoxies such as these are essential for repairing logs.

Finding a replacement log isn't the same as finding a log to build a new cabin. Replacement logs must closely resemble the appearance, shapes, and dimensions of the rotted logs. Each replacement log should be the same species as the rotted log, with a similar crown (the natural curve of the log) and matching diameter at both ends. If you will hew the log, the new log diameter should be 2 to 3 inches larger than the rotted log. If you have to, you can always take wood off a log, but you can't add it on.

Log replacement work is one area where planning ahead really pays off: cut replacement logs at least a year in advance of the project if possible. Cut straight, healthy trees or find straight, standing, recently dead trees, such as those left from a wildland fire. If you purchase replacement logs for a cabin with debarked logs, ensure that the replacement logs are already peeled and cured or are freshly cut so you can peel them relatively easily.

After you select and cut the log, move it to the worksite (figure 110). Remove the bark within a week of cutting a green log if the log will replace a debarked log. It's a lot easier to remove bark when the log is still green—the longer the log sits, the harder it is to remove the bark. Set it on sawbucks or saw horses so you can peel it without ruining your back (figure 111). Use log dogs to prevent the log from rolling.

Block green logs off the ground and let them cure for a year or two. Green logs take a long time to cure—sometimes as long as a year per inch of thickness. Most of the shrinkage, twisting, and warping occurs in the first or second year of curing, though. If you can allow the logs to cure longer, do so. Recently dead trees (less than 2 years dead) are already cured, but it is harder to get the remaining bark off standing dead trees than green trees.

If possible, arrange enough time for the initial curing before using the logs in the cabin. If necessary, you can cut a tree, shape it into a replacement log, and use it in a building in a day, but a green log shrinks 2 to 3 inches and may warp or twist as it dries. This shrinkage puts a lot of stress on the rest of the building. It may cause the structural members to separate or cause weak points, such as notching, to fail. Chinking and daubing won't survive the curing process and you will have to replace them after the logs cure.

Figure 110—This eight-person crew can safely and easily move a large log.

Figure 111—This crew used drawknives, shovels, and a bark spud to remove the bark from a replacement log for the cabin at Badger Station of the Lewis and Clark National Forest, Northern Region.

Round Logs

Round logs are the easiest building logs because they are simply cut and delimbed trees. Historically, people peeled most round cabin logs, but you can find unpeeled logs on small, rough, quickly constructed buildings, such as miner's cabins, and on some high-style rustic buildings. People shaped round logs with axes, saws, planes, and chisels (figure 112).

Some people coped round logs (sometimes called "Swedish coping") before setting them in place. A coped log has a U- or V-shaped trough cut down the length of its underside, mimicking the round shape of the log below it. To create a cope, secure the log top side down on low cradles if you're using an adz, or on sawhorses or sawbucks if you're using an axe. Use a stringline to mark the two edges of the area you will cope. Use the axe (figure 113) or adz to hollow out a depression on the inverted log, forming a curve that approximately matches the curve of the top of the log on which the coped log will rest when it's set in place. Use a curved adz (figure 114) to more easily create this arched shape.

To speed the coping process, people sometimes create the basic V-shape using a chain saw and add the curve with the axe or adz. Controlling the chain saw so that it carves out only the desired section is very tricky—do not attempt it unless you are an experienced sawyer. Carving out a little extra volume with the axe or adz helps accommodate the naturally lumpy shape of the log on which you will rest the coped log, but removing too much extra volume makes the joint leaky.

The purpose of coping is to create a log wall with no gaps between the logs. As you set each successive log in place, the edges of the cope crush slightly, so each log sits tight atop the log below it. If you cope expertly, chinking and daubing is unnecessary, although you may want to fill the space inside the cope with chinking to improve air tightness.

Figure 112—The author uses a chisel to shape the end of a log for the cabin at Badger Station of the Lewis and Clark National Forest, Northern Region.

Figure 113—This photo from the early 20th century shows a man using an axe to cope the logs for the Magee Ranger Station within what is now the Idaho Panhandle National Forest. He apparently had excellent balance and was an expert axeman. Safety wasn't a big consideration in those days. Swinging an axe without proper footing on the ground or on a solid platform is not safe—don't do it!

Figure 114—Secure the log upside down on the ground when you use an adz to create a cope.

Hewn and Sawn Logs

Sawn logs are round logs that people cut into square or rectangular timbers using large circular saws that leave distinctive curved saw blade marks on the log (figure 115). You can purchase sawn logs at sawmills or from loggers, or you can cut them onsite using a portable sawmill.

Hewn logs are round logs that people shape into square or rectangular timbers or partially squared timbers using axes (see figure 88). Partially squared timbers are called cants. Cants retain part of the natural log roundness, but they are flattened on one or two faces. The cutting and hewing process leaves distinctive marks on hewn logs (figures 116 and 117). The hewing marks on replacement logs should closely resemble the marks on the original logs. Hewing logs takes time and talent, but with some practice, nearly anyone willing to put in enough time to perfect the technique can hew good replacement logs.

An excellent explanation of how to hew logs is available in the Forest Service publication "An Ax to Grind" <http://www.fs.fed.us/eng/php/library_card.php?p_num=9923 2823P>, so it's not repeated here. Refer to the Hewing section of the Using Axes chapter of "An Axe to Grind." The drawings in figures 118 through 121 supplement the information in "An Ax to Grind" and illustrate the steps for hewing a log. Figures 122 through 125 show the appearance of logs during the process and how people use felling axes and broadaxes for these purposes.

To make the hewing process quicker and easier, use a chain saw (figure 126) or large circular saw (figure 127) to trim the log to a size slightly thicker than the desired dimension. Then, hew the log down to the desired dimension using a felling axe or double-bitted axe and broadaxe to obtain a finish similar to that of the log you are replacing. For a smoother surface, give the logs a final finish with an adz (figure 128) or drawknife.

Figure 115—A ranch crew constructed the Sage Creek Cabin of the Custer National Forest, Northern Region, using sawn logs. Weathering on the second log from the bottom shows the saw pattern more distinctly than the other old logs or the replacement log.

Figure 116—Hewn logs show distinct patterns that vary depending on the hewing method used and the skill of the hewer. The hewing marks disappeared from these wall logs because of exposure to many years of weather, but the vertical scoring marks from juggling are still visible. The publication "An Ax to Grind" (see website link on page 77) explains hewing and juggling.

Figure 117—The early 20th century builders hewed these logs expertly. Except for a few rough patches on the middle log, they left only very shallow, slightly scalloped marks when they smoothed the log faces with a broadaxe.

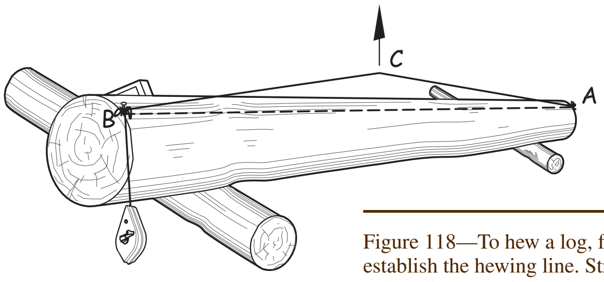


Figure 118—To hew a log, first establish the hewing line. Stretch a chalkline very tightly between nails A and B. Lift the chalkline up plumb and straight at C. Release the line quickly so that it snaps down onto the log, creating a chalkline to mark the line to which you will hew.

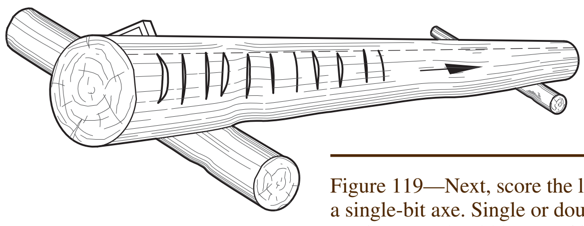
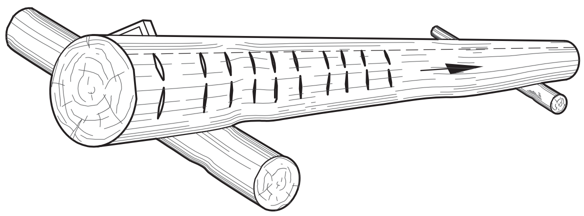


Figure 119—Next, score the log using a single-bit axe. Single or double scoring cuts should be 4 to 6 inches apart and almost to the depth shown by the chalkline. The upper drawing shows single slash scoring cuts. This method is suitable for use on logs from 8 to 12 inches in diameter. The lower drawing shows double slash scoring cuts. Double cuts, and sometimes even triple cuts, are suitable for use on logs larger than 12 inches in diameter. Make the scoring cuts 4 to 6 inches apart and almost to the depth of the chalkline.



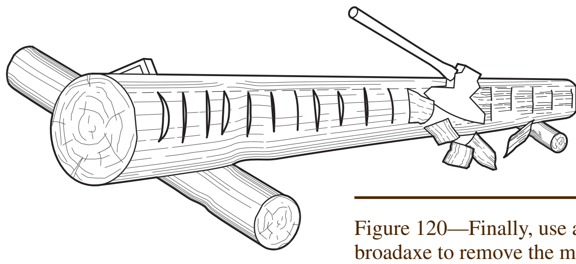


Figure 120—Finally, use a broadaxe to remove the material between the scoring marks and smooth the wood. Use the broadaxe with the blade parallel to or just slightly off parallel with the grain of the log.

Figure 121—On really big logs, it's often easier to score and rough-hew by juggling. To juggle, use a felling ax to chop a series of narrow, V-shaped notches about 12 inches apart, extending almost to the marked line. Then, use the felling axe to split the wood between the Vs off the log.

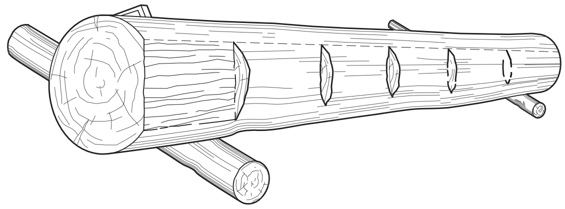


Figure 122—After cutting the juggling notches, use a felling axe to split the wood between the notches off the log.

Figure 123—After juggling, the surface of the log is relatively smooth and has vertical grooves. Match the appearance of the original logs. If the original logs show no sign of juggling or scoring marks, hew the replacement log with a broadaxe to remove the vertical grooves. If the original log is smooth, use an adz or drawknife after hewing to replicate the finish of the original logs.

Figure 124—When using a broadaxe to hew a log, some people stand with one leg on the ground and kneel with the other leg on the log.

Figure 125—When using a broadaxe to hew a log, some people prefer to stand with both legs beside the log.

Figure 126—After carefully marking the cut with a chalkline, this man used a chain saw to remove slabs from a log in preparation for hewing. These days, Forest Service chain saw operators must be certified and wear gloves, a hardhat, hearing protection, a long sleeve shirt, chain saw chaps, boots, and eye protection.

Figure 127—You can use a large circular saw, in this case a 16-inch circular saw, to remove a slab from a log.

Figure 128—An adz in skilled hands can create a remarkably smooth surface on a hewn log.

Sill Logs and Spandrel Logs

Sill logs are the two bottom logs of a cabin. They lie directly on the cabin foundation, on two parallel sides of the cabin, and they hold up the rest of the structure. People sometimes flatten sill logs on the bottom to provide better bearing on the foundation. As the bottom logs of a cabin, they usually are the most susceptible to rot, and the ones that most frequently require replacement. Floor joists usually are notched into or hung from the sill logs. Sill logs can be the trickiest logs to replace because of their connections to the floor joists.

Spandrel logs lie directly on top of and perpendicular to the sill logs. If the cabin floor rests on a center floor beam, it probably is notched into the spandrel logs. Refer back to figure 4 to see the relation between sill logs and spandrel logs.

Carefully remove in one piece deteriorated sill logs and spandrel logs that have joists or beams notched into them so that you can use them as patterns for the replacement logs (figure 129). Temporarily support the joists and beams on cribbing or needles before detaching the joists and beams from the sill and spandrel logs.

If the sill or spandrel logs are deteriorated, the joists or floor beams notched into or hung from the sills or spandrels are likely also rotted on the ends that abut them. Check joists and floor beams carefully for rot, and repair or replace them before putting the sill or spandrel logs back in place on the cabin.

Use the techniques for cribbing, jacking, repairing, and replacing sill and spandrel logs explained in the Log Removal and Replacement, Shaping a Log, Epoxies, Structural Wood Splicing, Surface Wood Splicing, and Crown End Repairs sections of this guide.

Figure 129—Preservation crewmembers prepared this new sill log for the Adams Ranger's House (Salmon River Ranger District, Nez Perce National Forest, Northern Region) using the deteriorated original sill log (not shown in the photo) as a pattern for the floor joist notching.

Floor Joists

Floor joists run the width or length of a room or building and act as the floor support and the tie that holds the base of the building together. Floor joists in log buildings can be hewn or round logs, or rough-cut or dimensioned lumber.

Floor joists usually are mortised into or hung from the sill logs (figure 130). Joist ends usually rest in mortise pockets notched into the interior half of the sill logs so that the joist ends aren't visible from the exterior of the building. A less common style extends the mortise across the top of the sill log so that the joist ends are visible from the exterior (figure 131). Joists hung from the sill log usually rest on 2x lumber nailed to the sill log. The builders of some 20th-century cabins set the floor joists into or hung them from the concrete foundation stem wall (figure 132).

Replace the joists in kind and replicate them carefully if they will be visible; especially the joist ends. If the joists and joist ends won't be visible, shape them to be close enough to the originals that they provide proper support for the floor and fit into the hangers or the pockets in the sill log or foundation. Plane the tops of log joists to level the floor. Figure 133 shows original log floor joists that the builder planed level.

If the joists or joist ends won't be visible when you complete the preservation work, you can replace the joists with modern materials (figure 134) if doing so improves the structure or is more convenient. Preservation standards permit the use of modern building materials and methods when they won't be visible after you complete construction. This allowance is particularly useful when the original structure can't accommodate plumbing; electrical; or heating, ventilating, and air conditioning (HVAC) systems, or isn't strong enough to support modern snow, wind, or live loads.

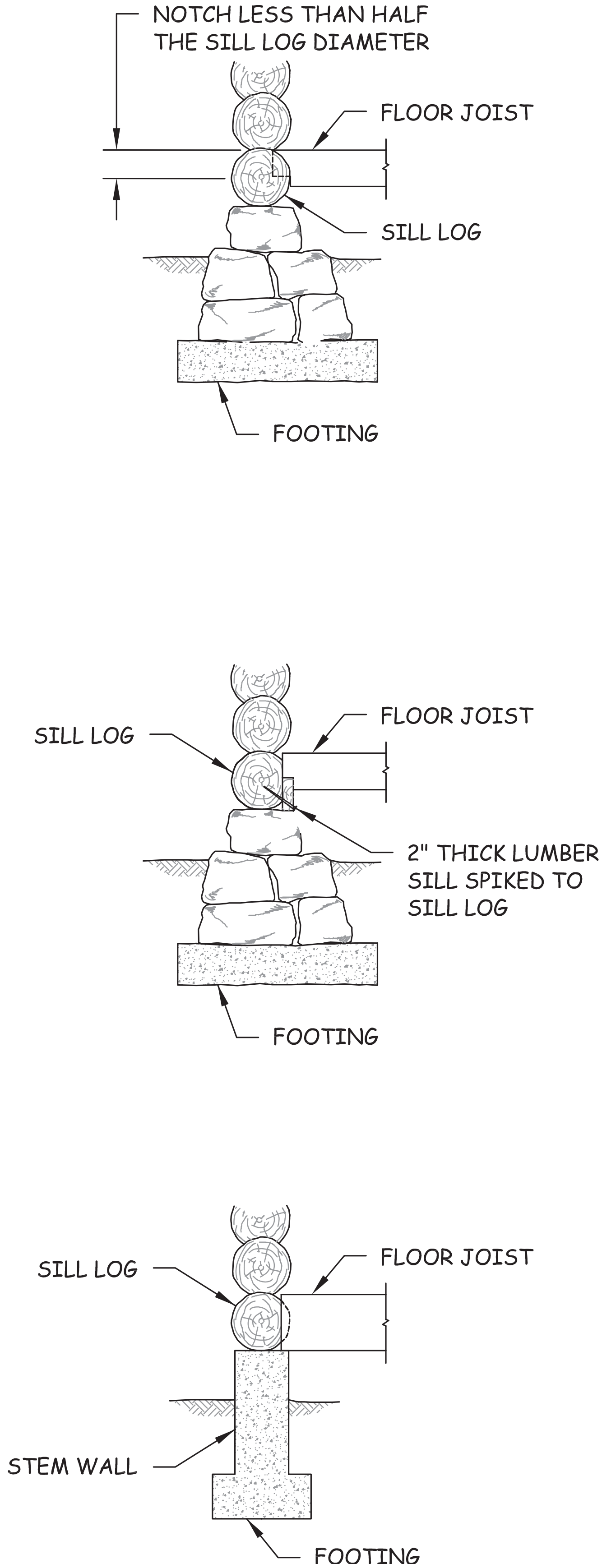


Figure 130—This drawing shows three methods for attaching floor joists. On the top, the joist is notched into the sill log. In the center, the sill log is hewn flat on the inside, a 2x4 lumber sill is spiked to the sill log, and the floor joist is notched to bear on the lumber sill. On the bottom, the sill log is notched on the inside to allow the floor joist to bear on the concrete foundation.

Figure 131—Preservation crewmembers replaced or repaired several logs of this lookout cabin. Just as in the original structure, the crewmembers set the floor joists in notches cut into the top of the sill logs. These notches are visible from the outside of the lookout cabin.

Figure 132—The builders set the floor joists at the Bull River Guard Station (Kootenai National Forest, Northern Region) on piers cast with the concrete foundation when they constructed the building in 1907. Over time, the foundation failed. Preservation crewmembers reinstalled the original floor joists on piers cast with the new foundation that exactly matched the original piers.

Figure 133—The builders hewed the tops of the floor joists at the 1931 Square Mountain Lookout (Nez Perce National Forest, Northern Region) so that the flooring would be level.

Figure 134—Preservation crewmembers replaced the failed original floor joists in one of the early 20th-century cabins at the OTO Ranch in the Gallatin National Forest, Northern Region. They used dimensioned lumber joists supported by steel joist hangers that they attached to treated lumber rim joists set into the new concrete foundation.

It is easier to repair or replace floor joists if you also must replace the foundation. Once you remove the old foundation, you'll have more space to access the joists. Better access is particularly useful if the builders originally used inadequate floor joists. If the existing joists are inadequate, replace them with larger joists or add intermediate joists so that the floor won't sag or fail. Common joist spacing is 12 to 24 inches on center, depending on the load on the floor and the subfloor strength. If you aren't certain whether the original joists are adequate, have a structural engineer evaluate the joists, subfloor, and floor load. Have a design professional size replacement or supplemental joists that are suitable for the structure.

Use the same techniques for replacing log floor joists as those explained in the Log Removal and Replacement and Shaping a Log sections of this guide. Never repair a floor joist with a splice. Floor joists are subjected to considerably more bending stress than wall logs, and splice repairs will lead to failure of the joist. When in doubt about a joist's integrity, always replace it.

Log Removal and Replacement

If the inspectors identified one or more deteriorated logs in the building condition and historic assessment, your preservation strategy and project plan should state whether you intend to repair or replace the deteriorated logs. You'll need to remove all the logs that you replace and may need to remove some of the logs that you need to repair. Before you remove a rotted log, inspect it from both the inside and the outside of the building to determine whether it supports any structural features. If it does, determine before beginning the replacement process how you can take up the load using bracing and cribbing.

Keep in mind that removing a log can be dangerous to you and the building, so jack, crib, and brace the building thoroughly and carefully at each stage of the replacement process. See the Raising and Leveling section of this guide for information about how to properly support the building. Remember that chinking and daubing will crack and fall out during the process and that you will have to replace them. Interior finishes, doors, windows, and floors may also be affected.

To begin the replacement process, first free the deteriorated log from the notches and other logs. If the deteriorated log is the sill log, jack and crib beneath the spandrel logs and raise the cabin off the sill log. Floor joists often are notched into or hung from sill logs. If the floor joists are attached to the log you are removing, make sure to disconnect components that are attached to both the floor and wall, such as base trim or cabinets, before jacking or wedging. Also, be very careful to support the floor on jacking and cribbing while you remove the sill log.

If the log won't fall out, pound wedges between the sill log and the log above it to loosen and wedge the logs apart. Check for anchor bolts, lags, dowels, or metal stakes in the log before trying to pull out the log. Cut connectors using a reciprocating saw (sometimes called a Sawzall) if they won't release when you insert wedges.

If the deteriorated log is a spandrel or mid-wall log and the logs above and below are sound, free the deteriorated log by pounding wedges only far enough into the joint between the logs above and below it on the adjacent walls to free the log at the notching. For example, if the deteriorated log is on the north side, pound wedges between the logs on the west and east sides that hold the north log in place. The wedges should spread the west and east logs only enough to let the north log slip out. If the cabin has locking notching, cut off all (figure 135) or the bottom half (figure 136) of the end of the log above it at the notch and save the cut piece. Mark the cut piece with an identifier (usually a compass direction and log course number) so that you can reattach it later (figure 137). Then, slide or pull the deteriorated log out with straps, pry bars, peaveys, or other tools.

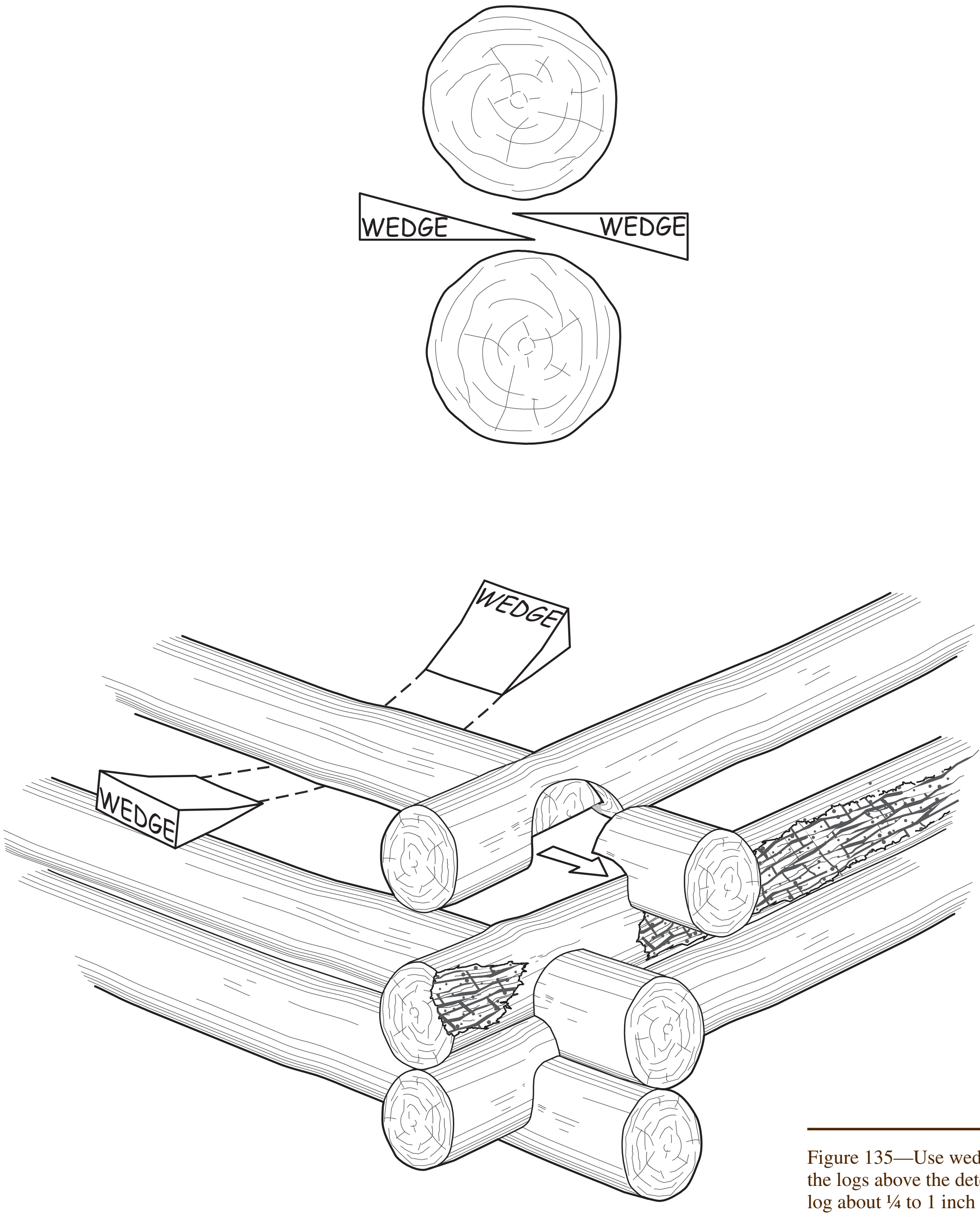
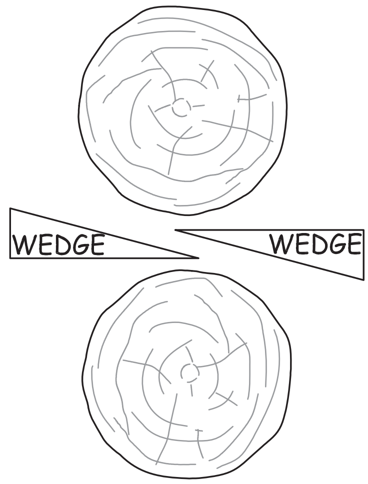


Figure 135—Use wedges to lift the logs above the deteriorated log about ¼ to 1 inch (shown much larger in the drawings for clarity). Cut off at the notch the full end of the log above to allow you to lift and slide out the deteriorated log.



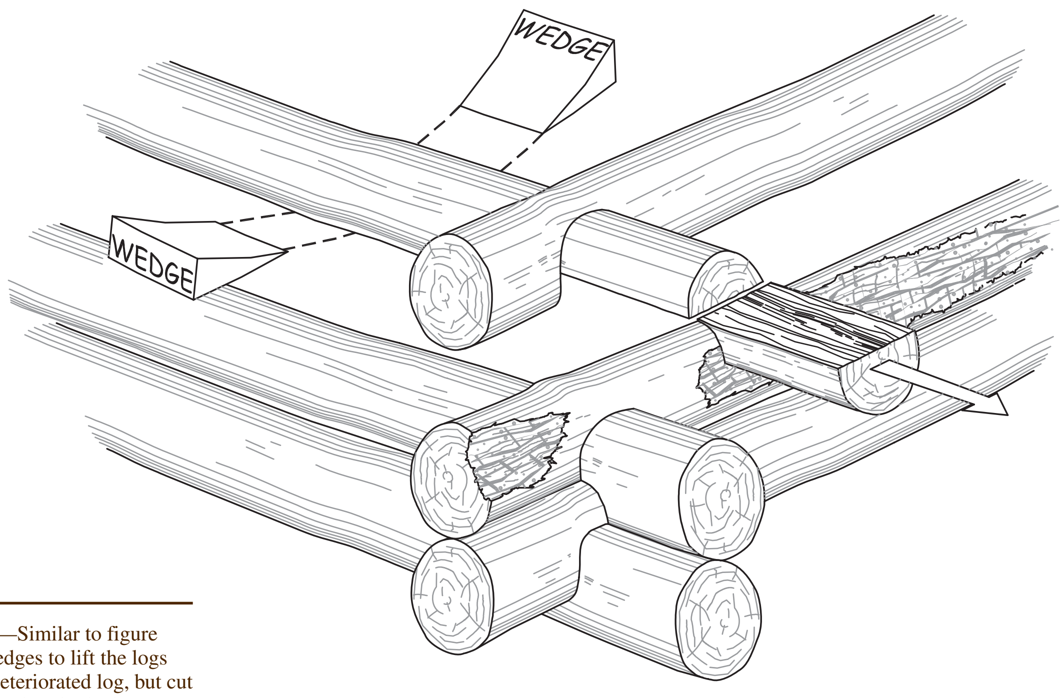


Figure 136—Similar to figure 135, use wedges to lift the logs above the deteriorated log, but cut off at the notch only the bottom half of the end of the log above.

Figure 137—If you cut off the end of a log to remove a mid-wall log, save and mark the piece so you can reattach it later.

If you can, retain in one piece the log that you removed. You can use it as a pattern for the replacement log, as explained in the Shaping a Log, Surface Wood Splicing, and Crown End Repairs sections of this guide. If you are replacing several logs, remove and label each log. Use the labels as a reminder of the order in which you should replace the logs in the building.

Keep in mind that the building becomes unstable when you remove a log, and even more unstable if you remove several logs. Be sure to adequately brace and crib the building to hold it safely in place.

After you shape the new log (see the Shaping a Log section of this guide) or repair the existing log (see the Epoxies, Structural Wood Splicing, Surface Wood Splicing, and Crown End Repairs sections of this guide), put it in place using levers, pry bars, brute strength (figure 138), and usually some persuasion from big commander mallets. Mid-wall logs tend to be especially difficult to insert. Don't be upset if the log doesn't fit correctly on the first try—each log is unique and the fit of each log with other logs also is unique. Look for high spots that prevent the logs from fitting together correctly and trim those areas (figure 139). The process of replacing logs usually includes putting the log in, marking places that don't fit properly, taking the log out, adjusting the log, putting it back in, and repeating the process until everything fits properly. If gaps between the new and existing logs are slightly wider than the original gaps, you may be able to camouflage them with chinking and daubing.

Figures 140 through 149 show the proper order for cribbing, jacking, removing deteriorated logs, and replacing logs in a small cabin. Because of the scale of the drawings, they don't show the necessary additional cribbing next to the jacks. As shown in the drawings, when you have to replace several logs, remove the wall logs from the bottom up, but insert the replacement logs in reverse order—from the top down (figure 150). As you put the replacement logs in place, adjust the jacking and cribbing to hold them in position. When the last log is in place, remove all the cribbing and jacks so that the cabin once again sits on its foundation (figure 151). The process is similar for larger buildings, but you will need to use additional bracing and support, such as needles, beneath the building.

Figure 138—This preservation crew is lifting a replacement log into position at the Landmark Ranger Station barn of the Intermountain Region's Boise National Forest. One crewmember holds the shaft of a large mallet that he will use to knock the log into its final position.

Figure 139—Replacement logs usually need a little more trimming, even after an expert shapes them, before they fit properly into place.

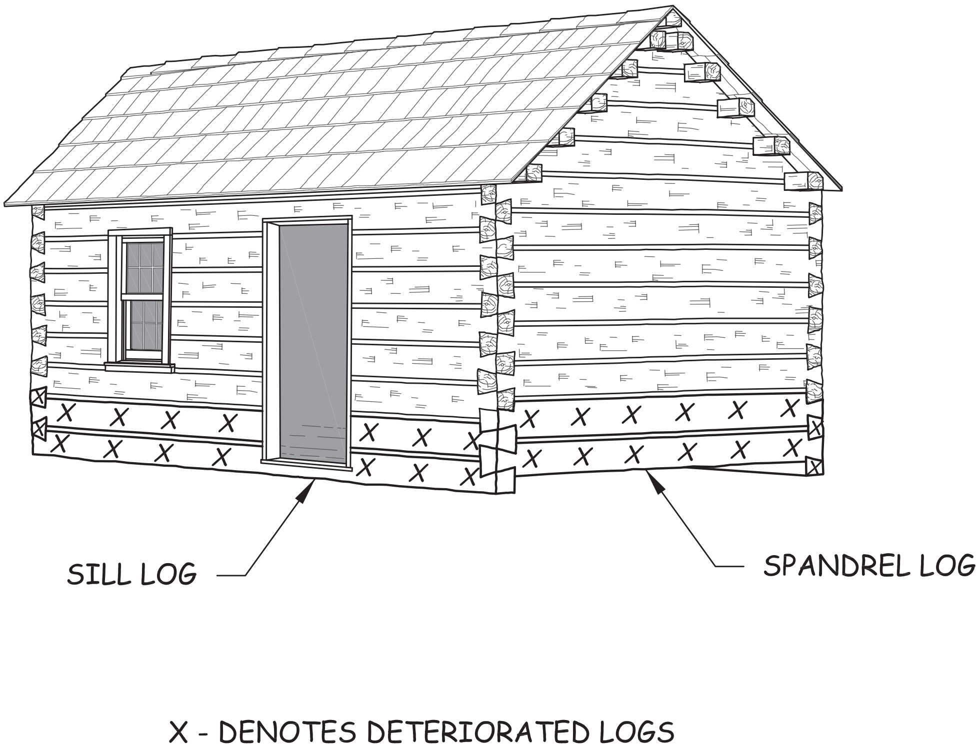


Figure 140—This drawing shows a small cabin with two deteriorated logs on each side. The logs marked with "X" are deteriorated. On this cabin, the sill logs are on the front and back of the cabin and the spandrel logs are on the ends. This is an important point, because the order of jacking and removal depends on whether the logs are on the sill side or spandrel side of the cabin. Each log on the sill side supports a spandrel side log, so if you remove them in the wrong order, some logs that you weren't going to remove will separate from the cabin.

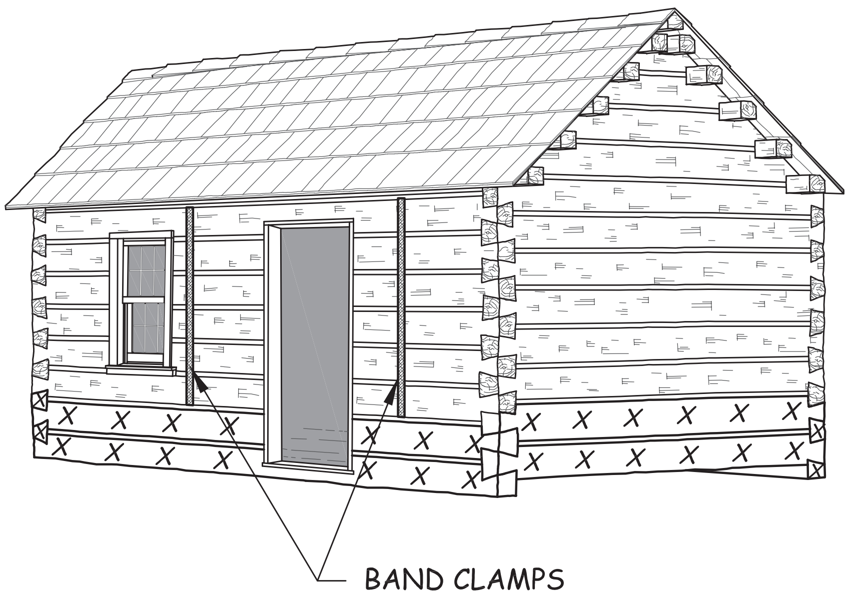
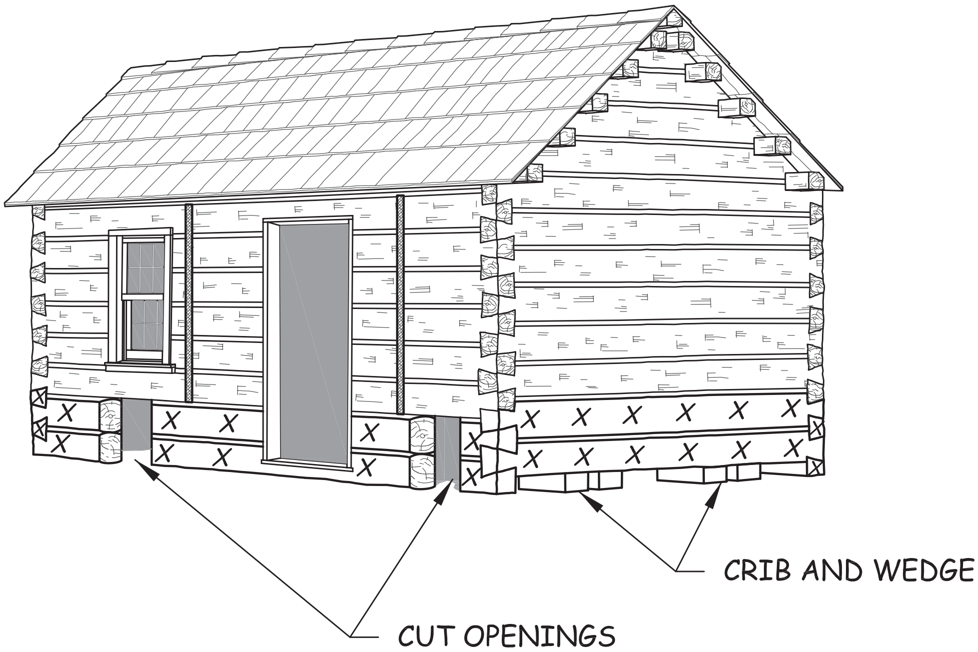


Figure 141—The first step is to place band clamps on each side of door openings and on each side of window openings that don't have at least one solid log beneath the windowsill.

Figure 142—Next, if the spandrel logs on both ends of the cabin aren't well supported by anything other than the sill logs, crib and wedge them (using miner's wedges) to hold them at their current elevation. Then, cut openings through the rotted logs on both sill sides of the cabin to place two screw jacks under the front wall and two screw jacks under the back wall. A chain saw is the most efficient tool for cutting the deteriorated logs. Warning: rotten logs may crush when loaded if deterioration is severe. This drawing shows a cut through two log courses on the sill sides to get to a solid log that will support the weight of the cabin.



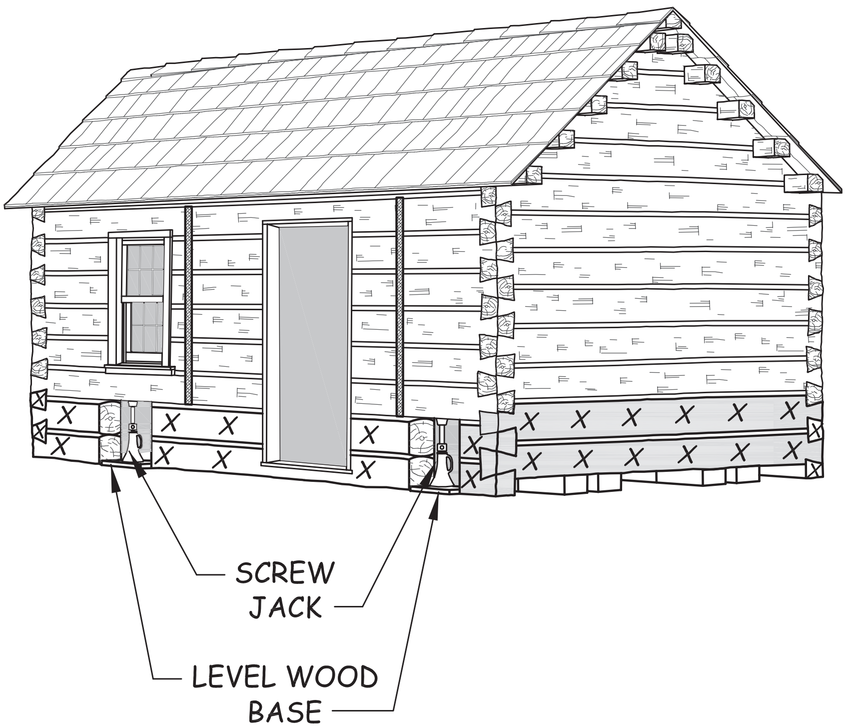


Figure 143—Next, place the screw jacks on level wood cribbing in the openings that you cut in the sill side walls of the cabin. Raise the jacks just enough so that they support the weight of the cabin. (Don't raise the cabin yet.) Then, remove the deteriorated (shaded) logs on only one spandrel log end of the cabin. Keep the deteriorated logs as templates for their replacements. Don't remove any of the logs on the other spandrel end of the cabin yet.

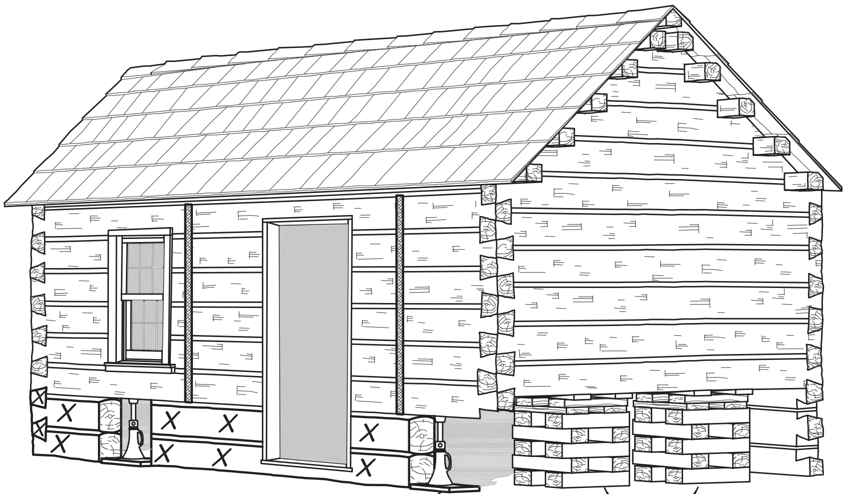
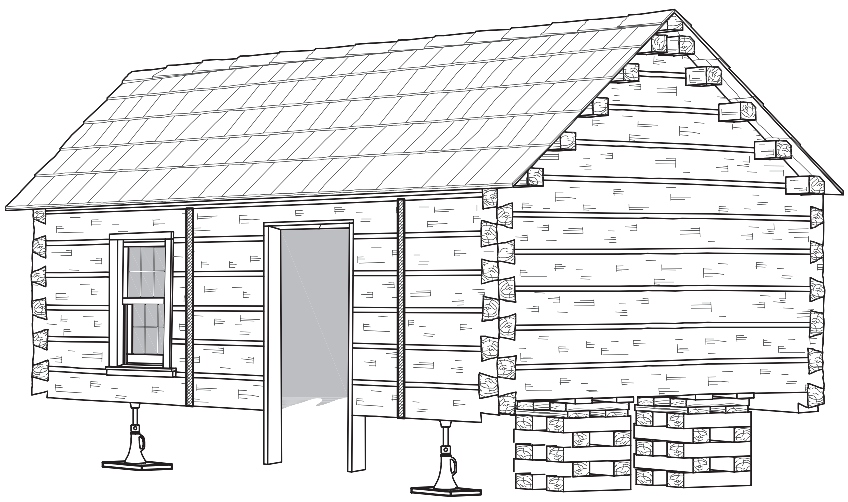


Figure 144—Level the earth and construct cribbing to firmly support the lowest solid log on the spandrel end of the cabin where you removed the rotten logs. Then, remove the deteriorated logs on the other spandrel end. Level the earth and construct cribbing to firmly support the lowest solid log on that spandrel end of the cabin.

Figure 145—Remove the remaining deteriorated logs on the sill sides (front and back) of the cabin. If any original logs are still sound and you can reuse them, carefully remove them in one piece. Store the sound logs and reinstall them in sequence. Keep the deteriorated logs as templates for their replacements. Now you can level the cabin. Raise the jacks a little at a time until the cabin is level. During this jacking and leveling process, be extremely careful to crib and wedge both spandrel walls frequently as you raise the jacks on the sill sides. You should also use additional cribbing next to the jacks (the cribbing is not shown due to the scale of the drawing). This strategy ensures that the cabin won't come crashing down if one of the jacks fails.



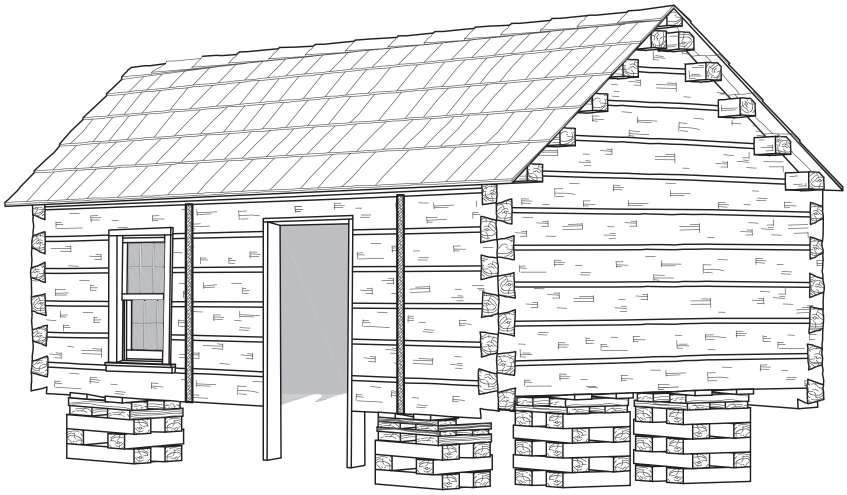


Figure 146—After leveling the cabin with the jacks, replace the jacks with cribbing that firmly supports all the logs. Cribbing now fully supports the cabin and the cabin is ready for repairs.

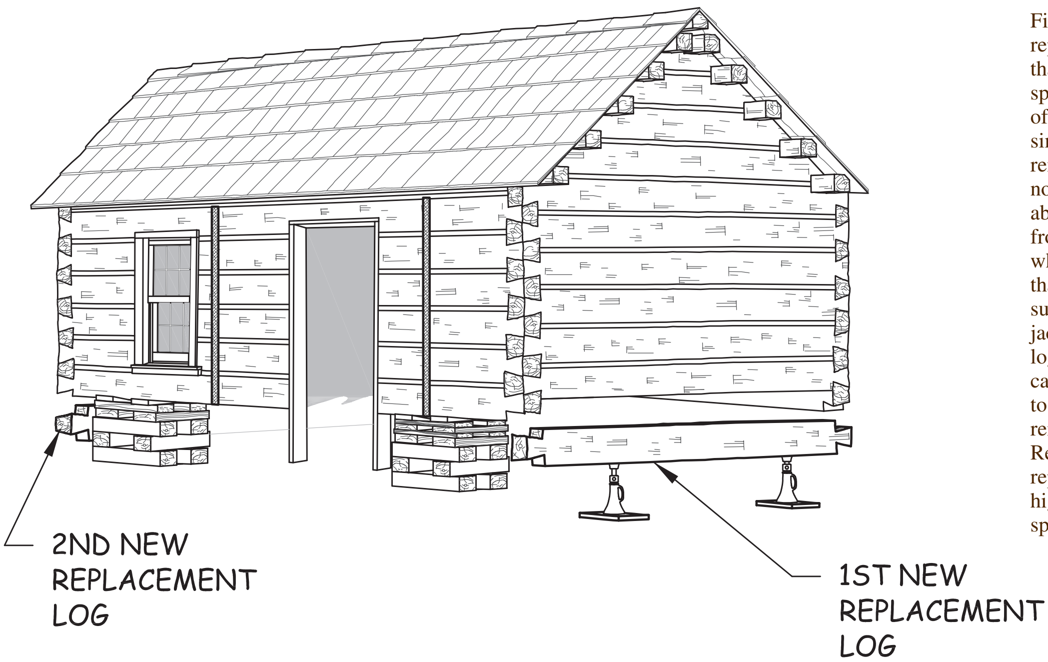


Figure 147—Fabricate a new replacement log for the highest log that you removed on one of the spandrel ends. The size and finish of the replacement log should be similar to that of the log that you removed from that location, and the notching should exactly fit the logs above. Carefully remove the cribbing from under the end of the cabin where the new log will go. Ensure that the side cribbing adequately supports the structure. Using screw jacks, position the replacement log under the spandrel end of the cabin. Crib the replacement log to firmly support the cabin and remove the jacks under the new log. Repeat this process for the second replacement log, which will be the highest replacement log on the other spandrel end of the cabin.

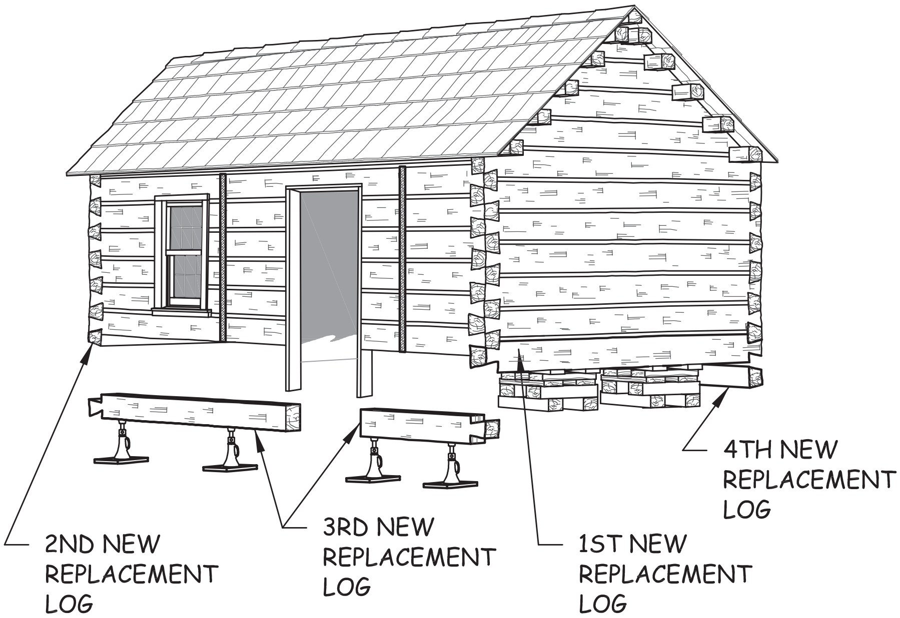


Figure 148—Fabricate the third replacement log for the highest log that you removed on one of the sill sides of the cabin. Carefully remove the cribbing from under the side of the cabin where the new log will go. Ensure that the spandrel end cribbing adequately supports the structure. Using screw jacks, position the replacement log under the sill side of the cabin. Crib the replacement log to firmly support the cabin and remove the jacks under the new log. Repeat this process for the fourth replacement log, which will be the highest replacement log on the other sill side of the cabin.

Figure 149—Use the same process explained in figures 146 and 147 to fabricate and install the remaining replacement logs. Install the replacement logs in reverse order from the original construction; top to bottom rather than bottom to top.

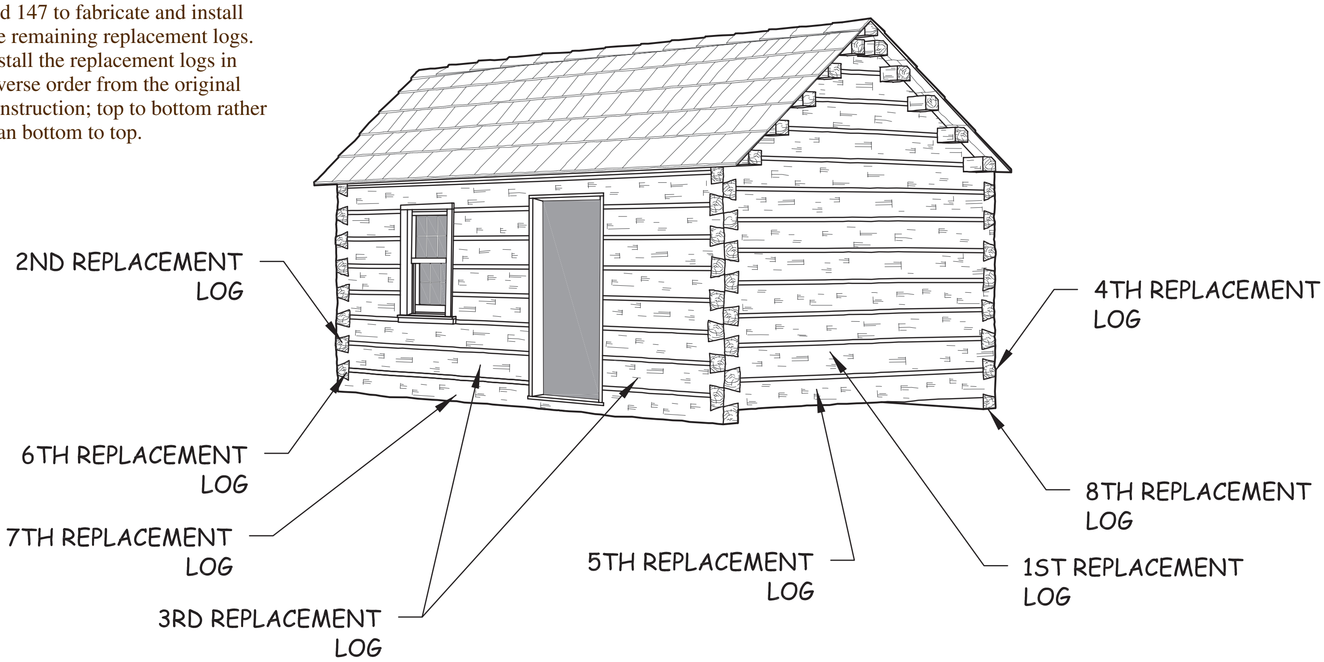


Figure 150—Set replacement logs in place from the top down. Trim the ends of the replacement logs to match the length of the original crown ends. Trimming is the only practical way to remove the red pencil lines. The new logs on this cabin aren't debarked because the original logs weren't debarked, although only a little bark remains on a few of the original logs. Most of the bark has long since weathered and fallen off the original logs.

Figure 151—Preservation crewmembers replaced the sill and spandrel logs, and this cabin once again sits on its foundation rather than on cribbing and jacking.

Once you put the replacement logs into their final positions, replace any crown ends that you removed to get the deteriorated logs out. Use epoxy to glue the pieces together and secure the repair with dowels, exactly like a crown end repair. Crown end repairs are explained in the Epoxies, Surface Wood Splicing, and Crown End Repairs sections of this guide.

Finish new logs in the same way that the existing logs are finished. If the existing logs are stained or painted, stain or paint the new logs with matching coatings. Carefully selected new paint or stain will look different for only one or two seasons, and then it will weather to look as though it belongs. If the original logs are coated with a linseed oil mix or a linseed oil mix with paraffin, treat the new logs with the same formula. See the Using Paint, Stain, and Oil section of this guide for information on log coatings.

Do not try to stain the new logs to match the color of the original logs if the original logs are not stained or painted. If you are unusually successful in matching the color, it might look good for 1 or 2 years. Over time, it will result in a long-lasting color mismatch because of differential weathering. Instead, leave the new logs untreated. After a couple of years, the new logs will weather to match the older logs.

Shaping a Log

After you remove the deteriorated log, use it as a pattern to shape the cured replacement log to match the original. If the replacement log doesn't match the dimensions and notching of the original almost identically, it won't fit properly into place. First, ensure that the diameter or hewn timber dimensions of the replacement log closely match the original log all along its length (figure 152). If the original log is coped or flattened, cope or flatten the replacement log. Use the techniques explained in the Round Logs and Hewn and Sawn Logs sections of this guide.

Figure 152—To make shaping a replacement log easier, place it next to the cabin in its correct orientation. Measure to ensure that the dimensions closely match those of the log that you removed.

When marking level lines, plumb lines, or shaping boundaries on a log, use only a graphite pencil, blue chalk, or a blue lead pencil. Marker ink and red chalk won't wear off and will bleed through any paint or stain applied to the log.

After you shape the log, cut the notches. To begin this process, secure the log in its proper orientation on low cradles, sawhorses, or sawbucks. Next, mark a vertical plumb line and a horizontal level line on each end of the log (see figure 152) so you can "re-true" the orientation if the log accidentally rotates while you're cutting the notches. Use log dogs or log cleats to hold the log securely in place.

For most log work, use a log scribe with a double level to mark the outline of each notch before you start carving. "True" the scribe before each project. To true the scribe, use a bubble level to find a board on the building with an exactly vertical face or nail a board onto a nearby tree with the face exactly vertical. On this board, draw a plumb (straight up and down) line. Because the line is exactly plumb right to left on a board that is exactly vertical front to back, the line is precisely vertical in two dimensions and you can use it to true the scribe. Adjust the pencil point opening to slightly more than the largest gap between the logs to be fitted, and with both tips against the plumb line, adjust both levels to read "zero."

Use the trued log scribe to mark the outline of each notch, using the original log as a pattern if possible. If the original is too deteriorated to use as a pattern, scribe the pattern using the existing logs above and below.

When carving notches between two new logs, match the notching style used on the rest of the cabin. Don't bother trying to exactly match the dimensions of the notches in the original logs that you removed—just carve the new notches to match each other.

Figures 153, 154, and 155 show how to use a log scribe to mark the outlines for saddle notches and steeple notches from adjacent logs. The process is similar for other notch types.

After you scribe the notch outline on the log, score the notch outline about ½ inch deep with a chisel. The scoring will prevent the log from splintering when you cut the notch, especially if you use powertools to cut out most of the notch. Powertools, especially chain saws, have a tendency to splinter cured logs. Do not remove too much wood at once. Remove what appears to be nearly the right amount, then move the log into place to check the fit and trim more wood out if necessary. Repeat this process for each replacement log.

Scribing Complications

Two situations commonly prevent using a scribe to copy the existing notch configuration to the new log:

1. Some logs are so deteriorated that not enough remains of the existing notch to copy.
2. If the log you're replacing is a mid-wall log, it isn't practical or wise to remove the adjacent existing logs just so you can position the replacement log for scribing purposes.

In these situations, make a pattern or use a dummy log.

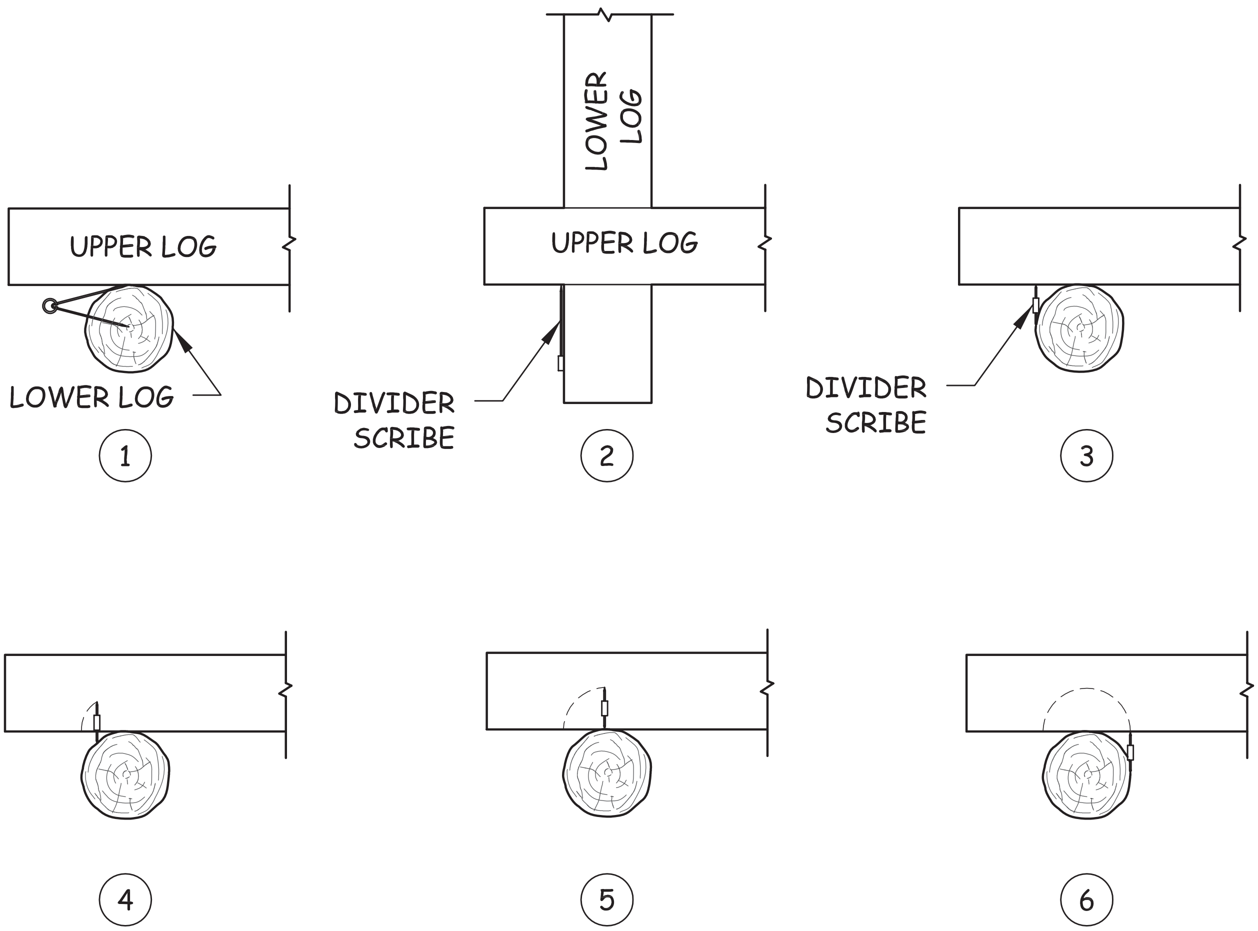


Figure 153—This series of drawings shows how to use a divider scribe to mark a saddle notch. For original log construction, start with the sill logs and work up. For replacement logs, start with the highest replacement log and work down.

1. Open the scribe to one-half of the diameter of the lower log and lock it in place.
2. Hold the scribe parallel to the lower log, as shown in this top view. Stand facing the side of the log to be marked and keep the points of the scribe aligned vertically during the entire scribing process.
3. Position the upper point of the scribe on the bottom of the upper log and the lower point of the scribe against the side of the lower log.
4. Keep both points tight against the logs and move the scribe upward in a circular motion to trace the outline of the curve of the lower log onto the upper log.
5. When you reach the top of the arc, move the scribe to the opposite side of the lower log.
6. Scribe the second half of the curve. Repeat this process for the opposite end of the log.

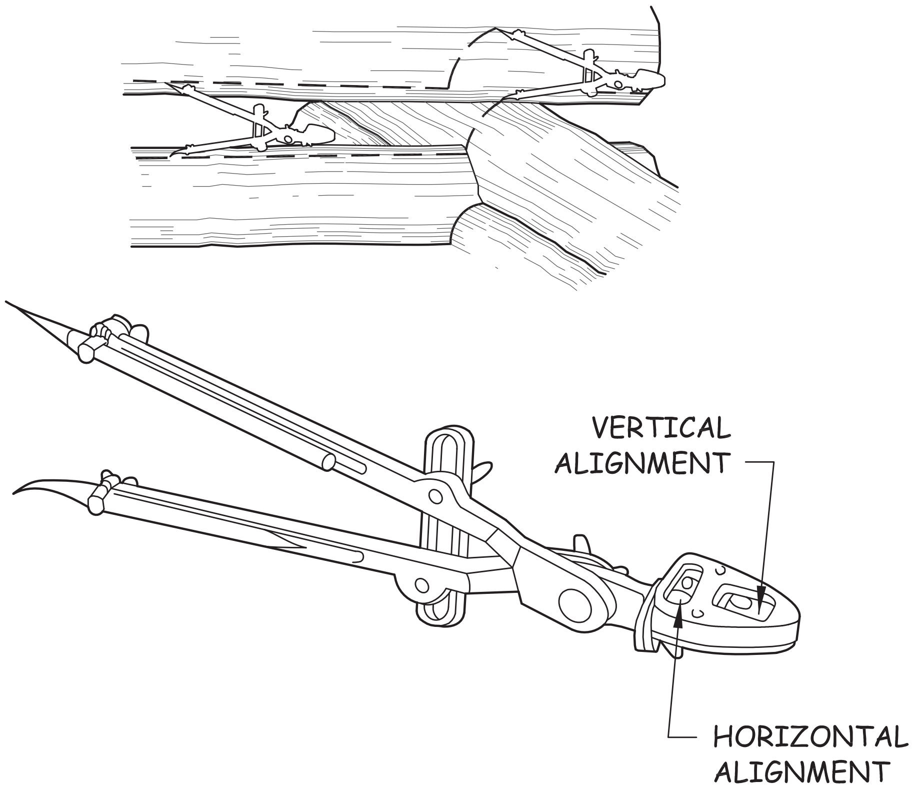


Figure 154—This detailed illustration shows a log scribe with a built-in level. It also shows how to use the scribe to mark a saddle notch on the bottom of a new or replacement log. Use the inner level to ensure horizontal alignment. Use the outer level to ensure vertical alignment.

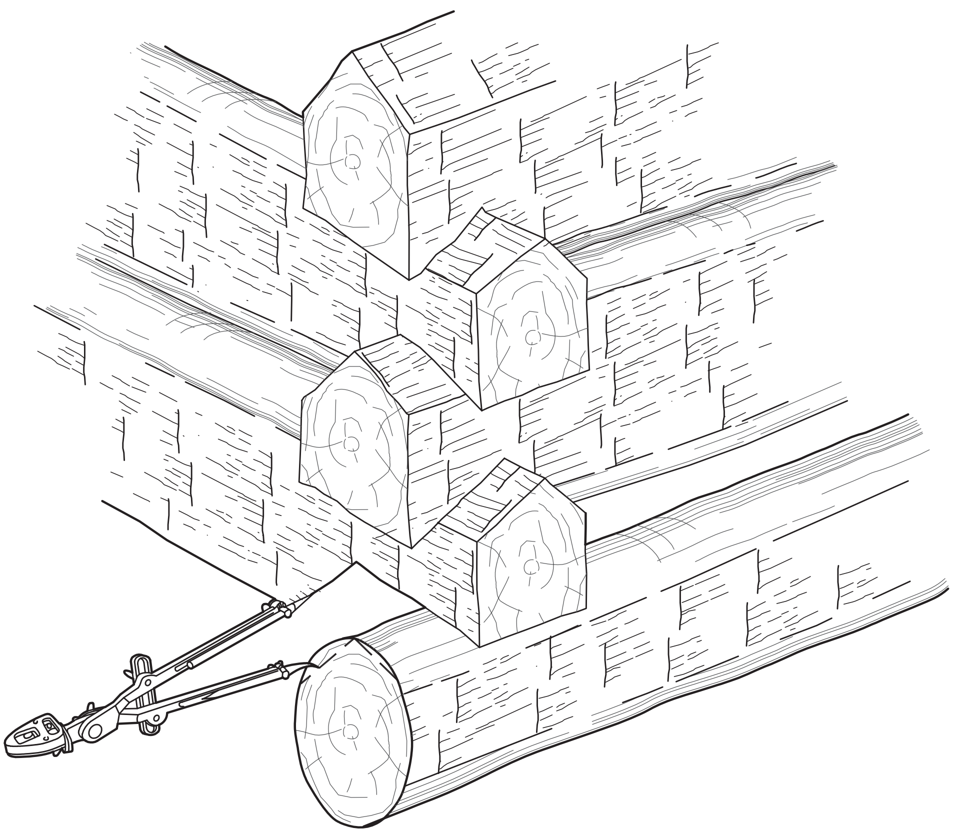


Figure 155—This illustration shows how to use a log scribe to mark a steeple notch on the top side of a replacement log.

Use only handtools to shape shallow notches. For deep notches, cut most of the wood out with powertools and dress the notch with handtools (figure 156) to erase the powertool marks. For example, use a chisel to take out the final inch or so of a notch that you rough cut with a chain saw.

When replacing several logs from the bottom of a cabin, mark and cut the notching in the top replacement log first and work down the building. Put each replacement log in place when you complete the notching.

To make a pattern, trace the notch from the adjacent logs on a piece of cardboard (figure 157) and then copy the pattern to the replacement log with a scribe, level, and tape measure.

For saddle notches and other simple notches, use a dummy (a log or portion of a log that matches as closely as possible the diameter and profile of the existing wall log that remains in place) to mimic a wall log still in the building. Shape the end of the dummy log to match the existing log, if necessary. Set the dummy log up on a sawhorse perpendicular to the replacement log. You must orient the dummy log to the log you are scribing as if both logs were in the building. Use the dummy log as a scribing guide (figure 158) to draw the notch on the replacement log. After you've marked the notch, cut it as previously explained. Be extra careful not to remove too much material at once because the dummy log probably will not be a perfect match for the log it represents.

Figure 156—Preservation crewmembers rough cut this steeple notch with powertools, but the carpenter is using a chisel to finish the notch shape.

Figure 157—You can use a cardboard pattern to scribe the outline for mid-wall saddle notches.

Figure 158—This preservation crewmember is using a log scribe and a dummy log to make a saddle notch for the Horse Prairie Cabin in the Beaverhead-Deerlodge National Forest, Northern Region.

Log Repairs

If the building condition and historic assessment reveals that only a portion of one log or only a portion of a few logs are deteriorated, repair those logs rather than replacing them. Stabilizing and repairing a log preserves more of the building's integrity, including historic tool marks.

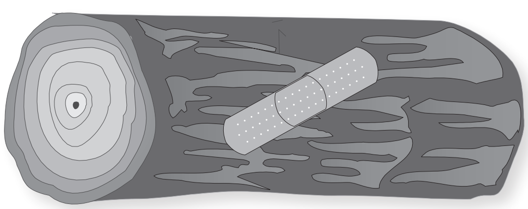
In some cases, large logs or timbers of the species originally used to build the cabin no longer are available. Repair prevents the need to substitute a different wood species, which would affect the visual integrity and lessen the historic value of the cabin.

You sometimes can accomplish log repairs without removing the log from the building. Repairs usually are cheaper and quicker than log replacements, especially if the logs are hewn or have complicated notches or large diameters.

Log repairs nearly always damage or destroy adjacent chinking and daubing. This damage isn't a problem because chinking and daubing are relatively easy to repair, and people normally repair or replace them many times during the life of a log building.

Repair work is easily hidden on painted or stained buildings: just coat the new work with paint or stain that matches the surrounding paint or stain. Repair and replacement work on unpainted buildings will be obvious for a few years, but eventually will weather to match the original logs. If someone treated the original logs with a linseed oil mix or a linseed oil mix with paraffin (see the Using Paint, Stain, and Oil section of this guide), recoat at least the entire repaired log, and preferably the whole building, after you complete repairs.

You can repair logs using epoxy patches, wood splices, or a combination of splices and epoxies. Repairs to logs are always visible to some extent. Perform the repair neatly with tight joints and do not attempt to camouflage the repair in any way other than by matching the surrounding paint, stain, or coatings.



Epoxies

Epoxy (see figure 109) is a useful log repair material that you can use as filler, as glue, or to solidify slightly decayed wood. A variety of liquid epoxies are available. All of them consist of separate containers of resin and hardener which you must mix before use. Epoxies resist decay and insects. Although epoxy is moisture resistant, it tends to cause adjacent wood to retain moisture because it blocks evaporation. Epoxy used in the wrong location actually can worsen wood decay. Epoxy repairs are most successful in areas where they are protected from moisture.

Be sure to select an epoxy product that meets the needs of the repair. Freshly mixed epoxy can be as thin as water to penetrate wood, or thick and viscous to stay put on vertical surfaces. Cured epoxy can be hard and brittle or soft and flexible. Cure time can be slow to enable deep penetration into porous wood or fast to enable a quick return to service. As epoxy cures, it generates heat. Thicker applications generate more heat, which can make the cure time faster. Epoxies for wood repairs are formulated to be compatible with the strength and flexibility characteristics of wood. Do not confuse these epoxy materials with epoxies formulated for other uses. Some epoxies accept dye and thickening agents.

Before using any type of epoxy, read the mixing instructions carefully. Wear disposable gloves and eye protection. Work in a well-ventilated area (outdoors or in a room with exhaust ventilation). Follow the respirator precautions on the safety data sheets (SDS), including when you grind or sand the cured material.

You can use epoxy to consolidate logs with slight surface deterioration. Mix the epoxy and brush it on the deteriorated area. The deteriorated log absorbs the epoxy, which fills the voids and stabilizes the log. Use epoxy sparingly, because it dries with a shiny finish. Drips and excess epoxy on the log surface are very noticeable.

You also can use epoxies to consolidate and repair small areas of rot inside a log if its outer surface still is sound. To consolidate a log without removing it from the building, drill small holes into the log in locations that you can conceal with chinking or daubing. Then, saturate the rotted area by pouring the liquid through a funnel into each of the holes.

Repair more extensive interior rot by removing the log from the cabin and using epoxy filler and epoxy adhesive to affix wood patches (figure 159). You may need to open the log to

Types of Epoxy Commonly Used for Wood Repair

- **Epoxy consolidant—**A liquid that soaks into wood and then hardens, solidifying the wood. The liquid penetrates dry wood better than wet wood.
- **Epoxy paste filler—**An adhesive paste made using thickener and additives to give the cured material strength and flexibility similar to wood. Paste filler is available commercially or can be made by mixing wood flour, sawdust, or silica into liquid epoxy. Filler consistencies range from that of mayonnaise to stiff mashed potatoes. You can dye some fillers to match the log. Always read the manufacturer's instructions to see what additives are appropriate for the epoxy.
- **Epoxy primer—**A liquid used to prepare a surface for good adhesion of epoxy paste filler. Be sure to review the manufacturer's directions, because some epoxies don't require primer.
- **Epoxy adhesive—**A liquid used to glue two pieces of wood together.

repair the rot, then rejoin it using the techniques in the Structural Wood Splicing section of this guide. Epoxy filler and patches won't work on logs with interior rot through more than a third of their diameter.

You also can use epoxies in combination with wood splices. Epoxy adhesives generally require only sufficient clamping pressure to keep the two pieces together without gaps and to prevent them from moving until the epoxy cures. The length of time you need to clamp the splice depends on the type of epoxy and the temperature. You roughly double the cure time for every 18 °F drop in temperature from 68 °F and cut it in half for every 18 °F rise in temperature from 68 °F.

Both the splice and the original log must be reasonably dry (about 6- to 20-percent moisture content) so that the adhesive bonds properly. Read the mixing instructions carefully, wear disposable gloves and eye protection, and do not breathe the fumes. For information on how to use epoxies as adhesives, see the Structural Wood Splicing, Surface Wood Splicing, and Crown End Repairs sections of this guide.

Epoxy isn't appropriate for all log repairs. For instance, you shouldn't use epoxy to conceal checking, for large surface patches that are exposed to view or weather, on logs with extensive decay, or on logs that are near collapse or have collapsed.

Figure 159—Preservation crewmembers chiseled out the rotted interior of this heavily coped log at Badger Cabin (Lewis and Clark National Forest, Northern Region). The author (left front) and crew replaced the removed material with epoxy, sawdust, and wood slabs. The rot was more extensive in the center of the log than at the ends. The outside of the entire log was sound. The crew split the log in half so that they could repair the interior, then rejoined the log using techniques in the Structural Wood Splicing section of this guide.

Structural Wood Splicing

Several methods of splicing (joining sections of wood together) are useful for log repair. The Surface Wood Splicing, Crown End Repairs, and Log Purlin End and Rafter Tail Repairs sections of this guide discuss different splicing methods.

Structural wood splices must be sturdy enough to support the building or a portion of the building. Figure 160 shows nine tenon, dovetail, scarf, and lap joints that people use successfully for log repair. Secure splice joints by using epoxy

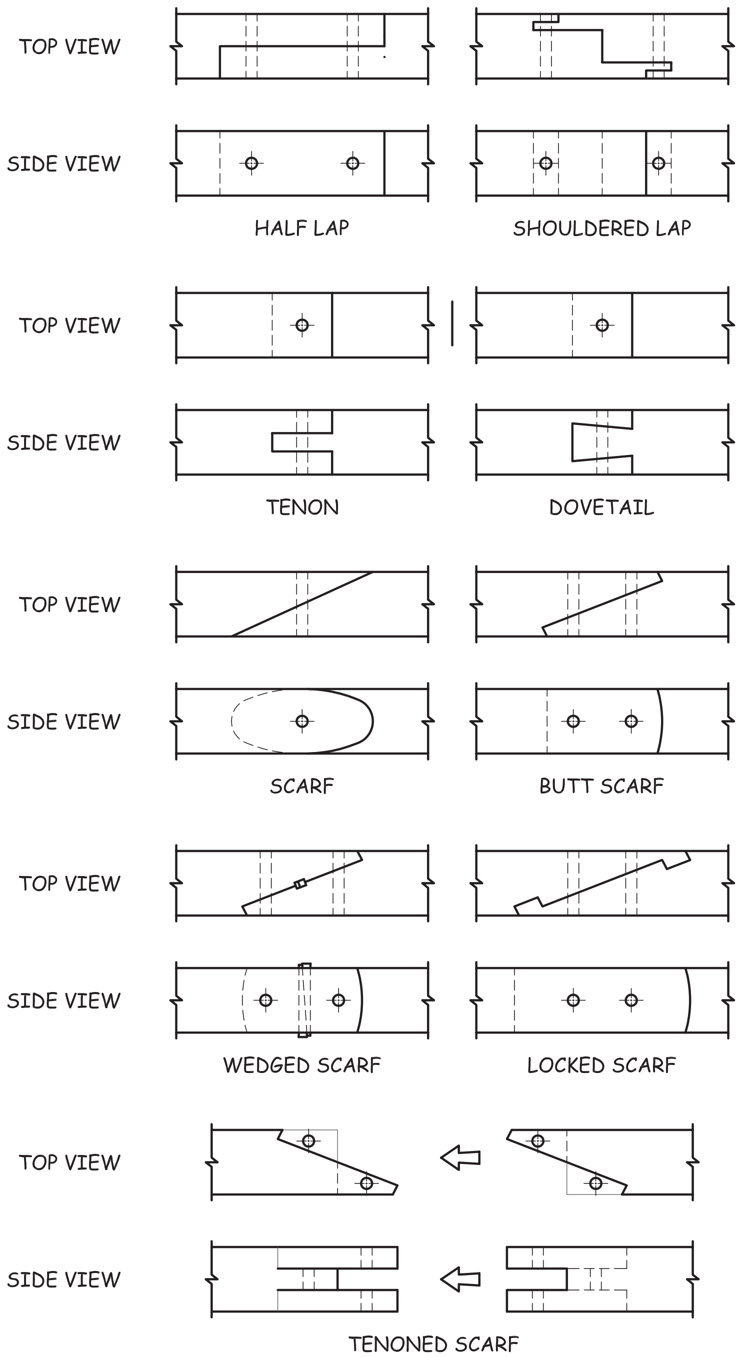


Figure 160—These line drawings show the configuration of nine fairly common splice joints in top and side views. You pin or dowel together each joint.

adhesive, wooden dowels, split-ring connections, bolts or all-thread and nuts, log or lag screws, or a combination of these fasteners. Figure 161 shows a split-ring connection being prepared for a lap joint.

You can secure a splice with either wooden or fiberglass dowels. Wooden dowels are relatively cheap and easy to find. After the repair, wooden dowel ends resemble knotholes. Fiberglass rods are gray and will stand out on logs that aren't painted. If you use fiberglass rods on unpainted logs, drive them below the finished surface, insert a wooden plug, and plane the plug flush for an appearance similar to a wooden dowel.

The stacked logs in a wall normally are subjected mainly to compression loads. The logs above window and door openings have minor tension loads. Sill and spandrel logs have tension loads if the foundation isn't continuous. For the compression loaded, stacked logs in walls, nearly any splice that holds the two pieces of log together will work to keep the building together. Of course, some splices are more durable, less noticeable visually, or more historically appropriate than others.

Logs subjected mainly to tension loads or combination tension and compression loads, such as posts, joists, rafters, purlins, or trusses, are a different matter. Never splice these structural members without first checking with a structural engineer to ensure that the splice will hold the load to which the log will be subjected. Without proper load analysis, you may find that your repair efforts are wasted when the roof caves in because the rafter breaks at the splice.

Figure 161—This photo shows one-half of a lap joint that the preservation carpenter will secure using split-ring connectors and bolts. She cut circular grooves for the split-ring connectors around the bolt holes that she drilled completely through both halves of the joint. One split-ring connector rests in its groove and another rests beside its groove. She will cut matching grooves in the other half of the joint, fit the two halves of the lap joint together, thread long bolts through the joint, and tighten the connection using nuts with washers. Split-ring connectors transfer the load between the two halves of a joint better than bolts alone.

Surface Wood Splicing

A surface splice is the appropriate repair technique if the building condition and historic assessment identifies a large surface area of deteriorated or damaged wood that extends less than halfway through the log. You accomplish surface wood splicing, usually referred to as a "Dutchman" repair, by cutting out the decayed area of the log, making a matching wood replacement plug or splice, and installing the new plug or splice (figure 162).

If the splice is long, consider easing the removal effort by scoring the deteriorated wood to the depth of the rot with a chain saw and knocking out the rot with a hammer (figure 163). Be careful not to cut adjacent logs. After cleaning out the deteriorated area, carefully cut smooth edges for the splice. Use one of the patterns shown in figure 164 to minimize the visual effect of the patch and any gapping that might occur because of differential shrinking or swelling between the patch and the original log.

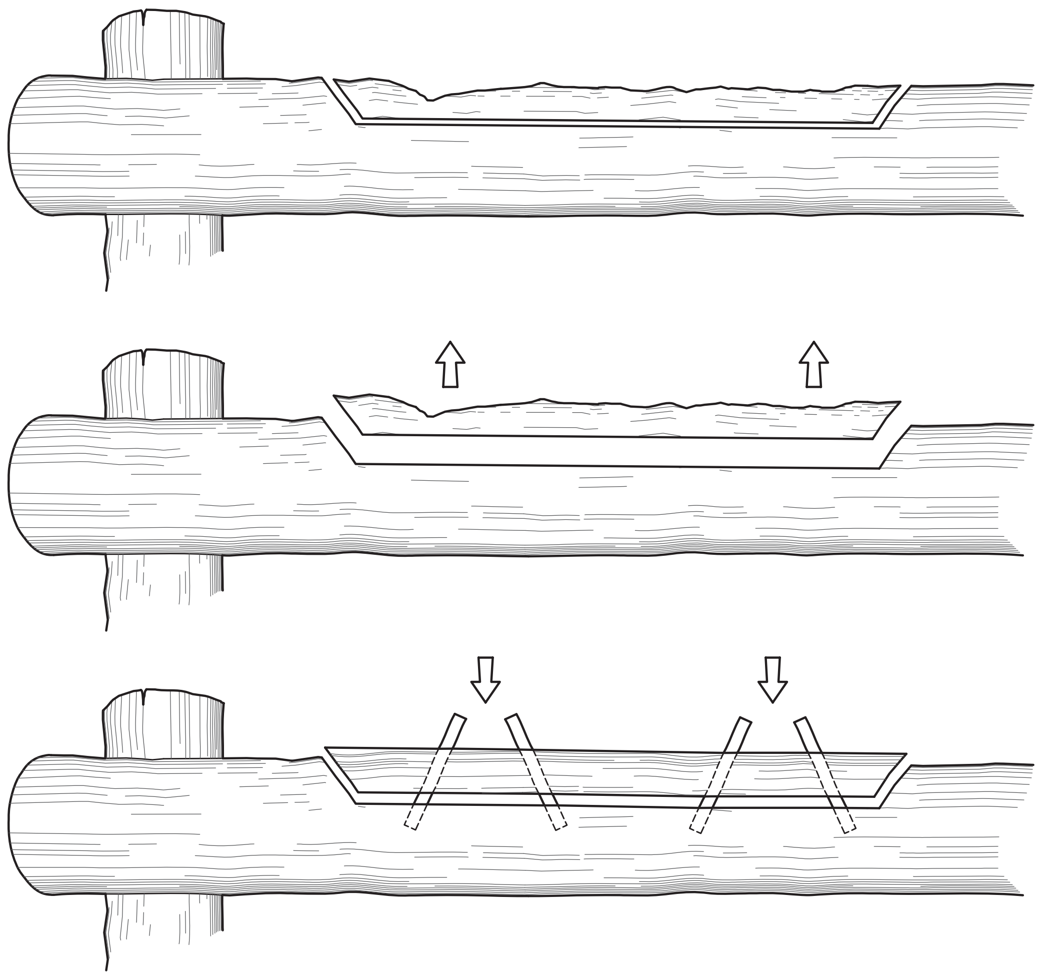


Figure 162—A Dutchman repair consists of removing a deteriorated section of log, making a matching splice, and attaching it to the log.

Figure 163—You can use a hammer to knock the rotted wood off a log after scoring the area with the tip of a chain saw.

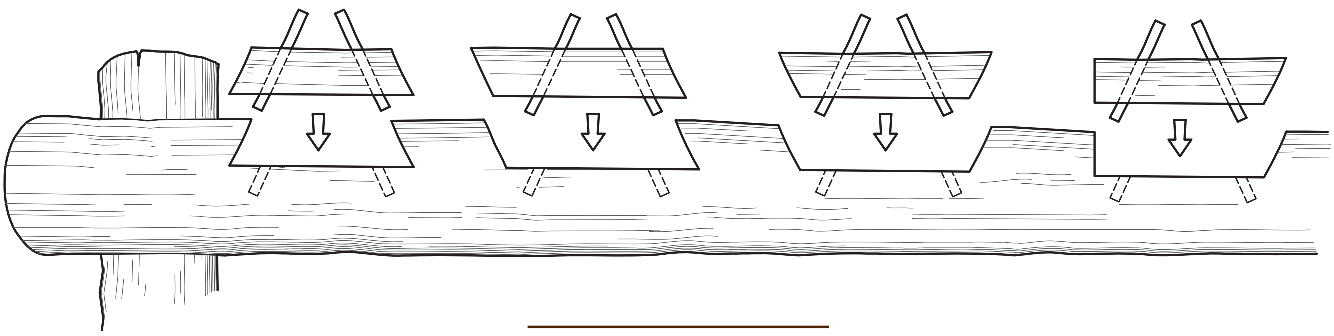


Figure 164—Cut clean edges for a log splice in one of these patterns. This drawing also shows the angle for attaching dowels.

Cut the plug or splice from a log of the same species as the log you are patching. Match the direction and pattern of the wood grain and the shape of the cut out area (figure 165). Make a pattern from a board or use a profile gauge to aid with cutting the splice to fit exactly into the cut out area. Trim the plug or splice as necessary to fit exactly into the log you are patching. Don't worry if the splice extends beyond the original log surface a little, as long as the ends of the splice fit snugly into the log with no gaps.

When you've completed shaping the plug or splice to exactly fit the existing log, apply epoxy adhesive to the cut surface of the existing log. Clamp the patch into place and let the epoxy cure. If necessary, use screws to help hold the patch in place until the epoxy cures.

After the epoxy cures, create a permanent attachment between the patch and the existing log using dowels. With the clamp still in place, drill paired diagonal dowel holes through the patch and into the existing log. Use wooden dowels at least ¾ inch in diameter. Drill the holes for the dowels only slightly larger than the diameter of the dowels and extend them into the existing log a little less than one-half the remaining depth of the log. After drilling the holes, coat the dowels with epoxy adhesive and place them into the predrilled holes. Use a rubber or wooden mallet to drive the dowels to the bottom of the holes. Wipe off any excess adhesive.

After the epoxy cures, remove the clamps and screws and do any final trimming necessary to remove excess dowel material. Shape the surface of the patch to match the existing log. Figures 166 through 173 show the entire Dutchman repair process.

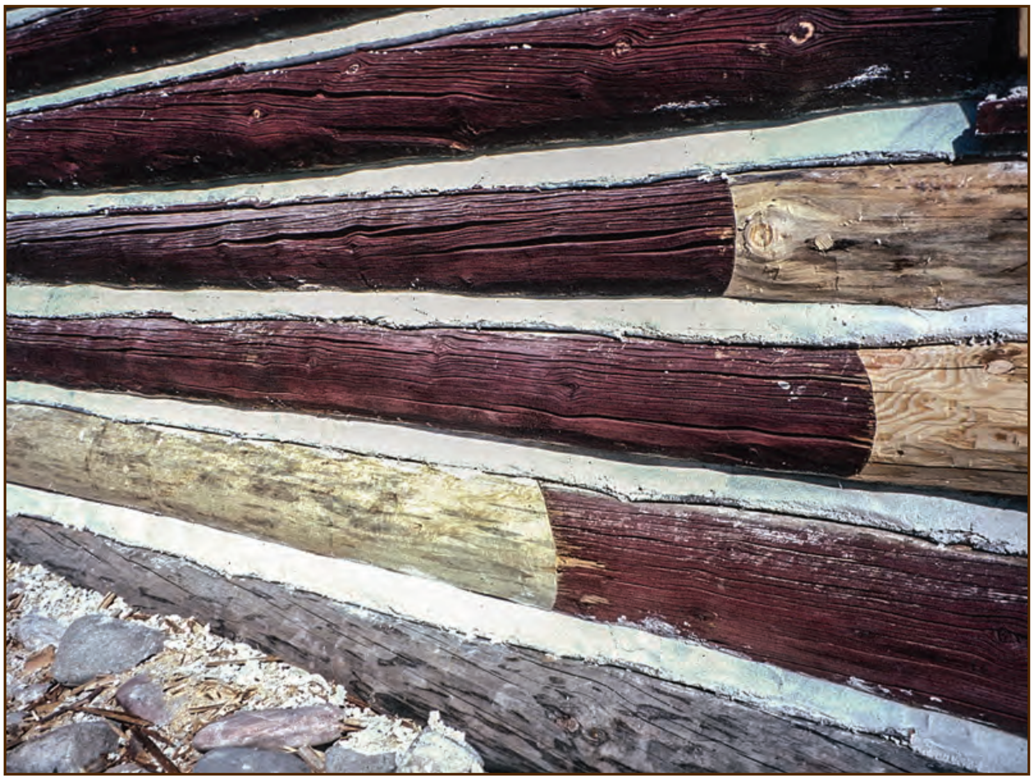


Figure 165—This photo shows several trimmed Dutchman splices on exterior logs of the Judith Guard Station (Lewis and Clark National Forest, Northern Region). Although the species and diameter of all patches match well, the middle splice does not match the original log grain pattern as well as the top and bottom splices do.

Figure 166—This whitewashed cabin has a small, deteriorated area beneath one of the windows.

Figure 167—Preservation carpenter Bernie Weisgerber, now retired from the Forest Service Northern Region Historic Preservation Team, used a mallet and chisel to remove the deteriorated wood, which was more extensive than it appeared at the surface. Notice that he removed the chinking and daubing adjacent to the deteriorated area so that he could more easily access the damaged area.

Figure 168—The preservation carpenter used a reciprocating saw to cut a clean edge at an angle on the end of the cut out area.

Figure 169—There is a small epoxy patch at the back of the finished cut out area. The log is dry and the epoxy and surrounding wood will be well protected from moisture in this location once the preservation carpenter replaces the chinking and daubing.

Figure 170—The preservation carpenter cut a board to match the length and angles of the cut out area as a pattern for cutting the splice.

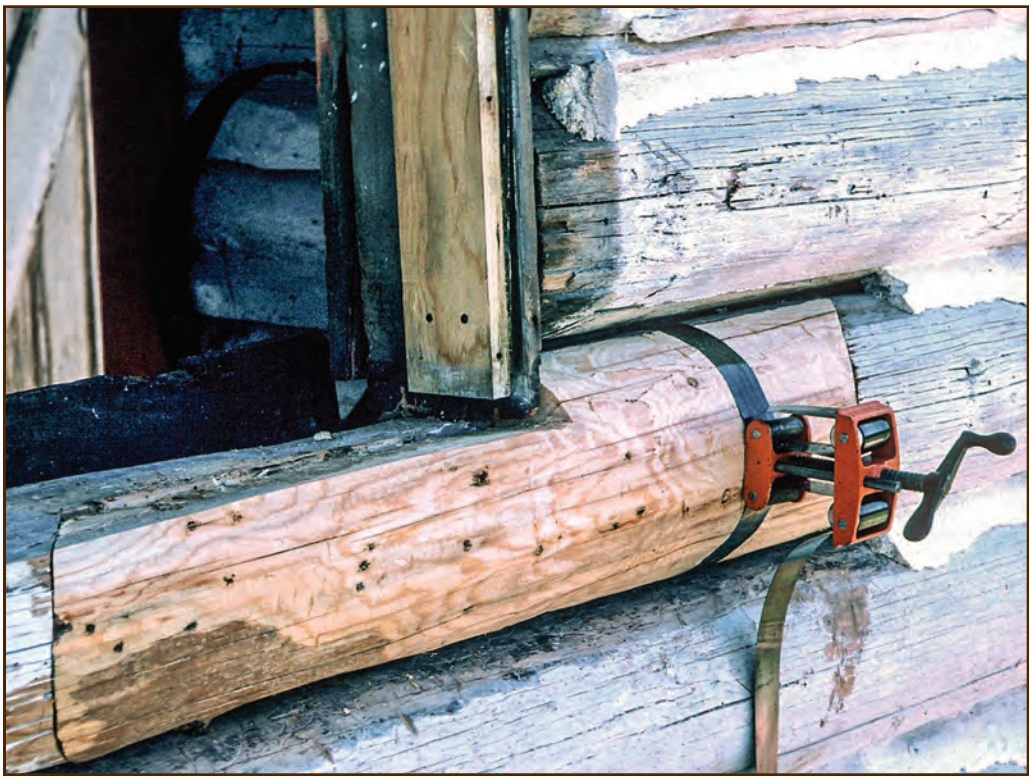


Figure 171—The preservation carpenter removed the original windowsill and cut the top of the splice down for the windowsill. He applied epoxy adhesive behind the patch and secured the splice to the original wall with a band clamp. The splice fit perfectly into the notch. Next, he drilled the dowel holes.

Figure 172—The ends of the angled dowels are darker ovals that are visible toward the ends of the splice. The epoxy has cured and the preservation carpenter has removed the band clamp.

Figure 173—The preservation carpenter has repaired the chinking and daubing and applied whitewash to the patch, which is just barely noticeable. The whitewash didn't penetrate the new splice as well as the original logs. By the time the cabin needs another application of whitewash, the splice will have weathered and will absorb the whitewash more uniformly.

Use a process similar to a Dutchman repair to reattach a crown end piece that you removed to free a mid-wall log for replacement (figure 174). The only differences are that the crown end piece you will reattach is the original crown end piece that you removed, and it's on the end of the log rather than in the middle. Gluing, clamping, and doweling procedures are the same.

You can also use a splice to repair the entire length of a log or the full diameter of one end of a log. Half-log splices replace all or part of the outside face of a log (figure 175); end-to-end log splices replace the full diameter of a portion of a log (figure 176). Both types of splices are useful for buildings with heavily coped logs and for buildings with intact historic interior finishes that you shouldn't disturb. Because these splices are quite large, orient the finished splice vertically to prevent moisture from entering the splice and becoming trapped in the repair. If more than one-half of the log is deteriorated, you usually are better off replacing the entire log.

End-to-end log splices require you to remove and replace the deteriorated end of a log. To make an end-to-end repair, cut off as much of the log as necessary to remove all the rot. Find a new log that matches the species and diameter of the cut off end as closely as possible. Cut a half lap that is 18 inches to 2-feet long into both the remaining existing log and the replacement log section. Splice the two together to create one log. This repair is easiest when you remove the log from the building, but you can do shorter repairs while the log is in place. Because this repair is major, use two to three split-ring connections with all-thread running through the rings to secure the half-lap splice.

Figure 174—Preservation crewmembers removed the bottom of a crown end log on the barn at the Moose Creek Wilderness Station (Nez Perce National Forest, Northern Region) to free the log below it for replacement. The new log (lighter color) is in place. The piece that the crew removed is glued and doweled back into position and is held in place by a band clamp while the epoxy adhesive cures. Next, the crew will trim the dowels and stain the replacement log and dowel ends to match the existing logs, providing a nearly invisible repair.

Figure 175—This photo shows several types of splices in various stages of completion on a cabin with coped logs. The lower two logs on the end of the cabin and the third log up from the bottom on the side of the cabin contain nearly completed half-log splices that extend almost the full length of the logs. Above the half-log splices on the end of the cabin are two logs that preservation crewmembers cut to receive face splices. The crew will apply face splices without removing the logs from the cabin. A couple of other logs further up the end of the cabin show evidence of rot; the crewmembers also will treat these with face splices.

Figure 176—Preservation crewmembers replaced the ends of the porch sill logs at the Gates Park Station cabin (Lewis and Clark National Forest, Northern Region) using end-to-end log splices. They replaced the porch foundation, spandrel log, posts, and floor boards at the same time.

Use half-log splices when one face of a log has extensive deterioration that doesn't extend past the middle of the log. To make a half-log repair, remove the log from the building, set it securely on sawbucks, and cut the log in half lengthwise to remove the deteriorated face. Find a matching log and cut it in half lengthwise. Splice the two together to create one log (figure 177). Because this repair is quite extensive, secure the splice using several split-ring connections (figures 178 and 179) with all-thread bolts in the center of the rings that extend completely through the old log and the splice. You can do this repair to a heavily coped log while it remains in place, but doing so is quite difficult (see figure 175).

Split rings, when used correctly, create a repair that is as strong as the original log. One manufacturer's design manual for split rings, which includes spacing and load charts, is available at <http://clevelandsteel.thomasnet.com/Asset/Design_Man_Teco.pdf>. Recess the bolt, nut, and washer into the log and cover them with a glued-in plug (figure 180). Orient the grain of the plug in the same direction as the grain of the log for a neater, less noticeable repair.

If the original logs are painted, stained, or sealed, apply a matching finish to the splice. Repair the chinking and daubing as explained in the Chinking and Daubing section of this guide.

Figure 177—This photo shows a half-log splice in progress. The crew has not yet completely shaped the pale new wood to match the wood it will replace. This splice doesn't include the end of the existing log because the end was sound, and the crew didn't need to repair it. Using a half-log splice allowed the crew to keep the historic interior finish intact. It is always best to retain as much historic material as possible.

Figure 178—The center guide rod on a drill bit for split-ring connectors is the same diameter as the threaded bolt that goes completely through the old log and the splice. Clamp the old log and splice together, then drill the hole for the bolt completely through the log and splice. Take the old log and splice apart. Drill the ring depressions separately into the meeting surfaces of the old log and the splice. Place the guide rod of the split-ring connector bit into the bolt hole to keep the ring bit centered as you drill the ring depressions.

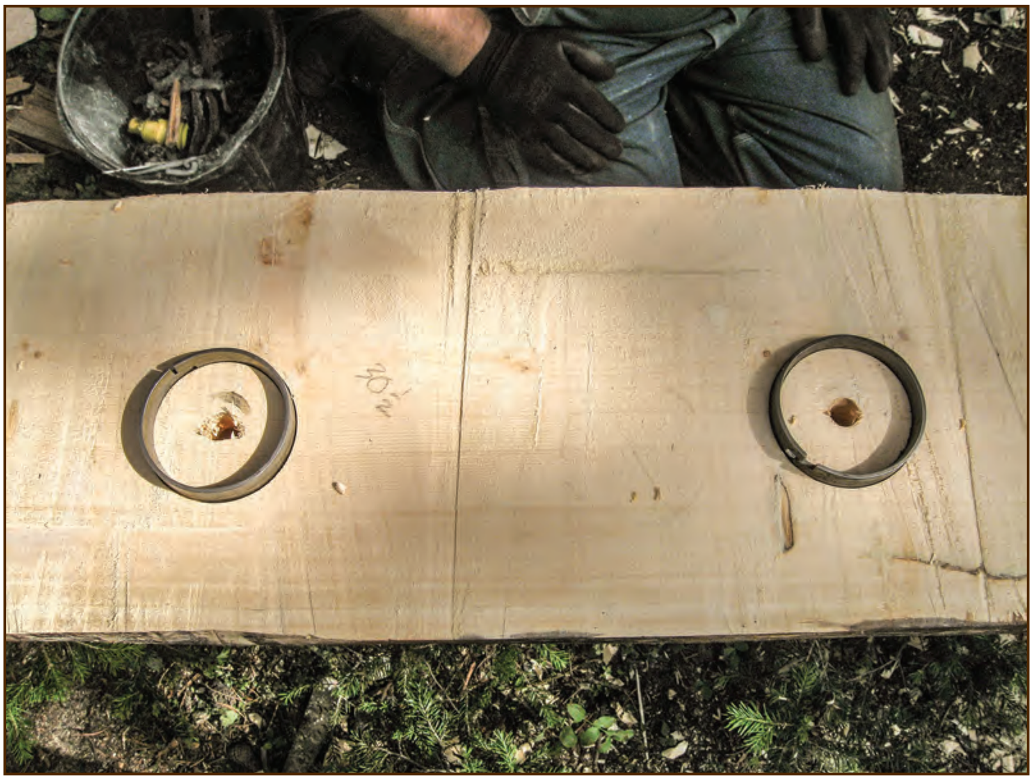


Figure 179—Preservation crewmembers recessed split-ring connectors halfway into this splice. They also will recess the connectors halfway into the old log. Next, they will put the splice and log together, thread the bolt through the matching center holes in the splice and old log, and secure the connection with nuts and washers.

Figure 180—This closeup photo of the outside of a spliced log shows the recessed bolt, nut, and washer of a split-ring connector. The plug that the preservation crew will glue in place to cover the recessed bolt and nut sits on the log beside the recess.

Crown End Repairs

Crown end repairs are the most frequent repairs preservation carpenters do on log buildings. If your building condition and historic assessment identified rot in the ends of the logs beyond the notches, you may need to replace all or part of the crown ends (figure 181). Often, a crown end needs only a small Dutchman repair, but sometimes you must replace the full crown end into the notch or beyond.

Follow the directions on Dutchman repairs described in the Surface Wood Splicing section of this guide. If only the top, bottom, or side of the log is deteriorated, only cut off that part and replace the piece, much as you would a mid-log splice.

If the deterioration extends into the notch or beyond, cut off the rotted end (figure 182), making sure to remove all the rot and a couple of inches of sound wood so that you have a solid attachment point for the repair.

Save as much of the removed crown end as possible to use as a pattern to replicate the notch and crown. Use the techniques described in the Selecting and Preparing Logs, Round Logs, Hewn and Sawn Logs, and Shaping a Log sections of this guide to find and shape a replacement portion of log to match the original crown end. As with other repairs, you may need to do several rounds of fitting and shaping until the new crown end fits in place well.

You can attach the new crown end with epoxy and hidden dowels, exposed dowels, log screws, or lag screws. Installing hidden dowels requires precise patterning and a good deal of skill and craftsmanship. To use hidden dowels, drill two holes only slightly larger than the diameter of the dowels 4 to 6 inches into the original log. Drill corresponding holes into the new crown end. Ensure that the total length of each pair of dowel holes is a little more than the length of the dowels. Coat one end of each of two wooden dowels

How To Mark a Guideline

Making a perpendicular cut to remove the end of a log is difficult. Here's how to use a guideline to help keep your cut straight:

1. Knock out any chinking and daubing that are in the way.
2. Wrap a length of steel band or a strip of thick asphalt building paper around the log a couple of inches beyond the edge of the deterioration.
3. Align the edges where they overlap.
4. Draw a line along the edge of the band or tar paper. Now you have a guideline for making a straight cut all the way around the log.

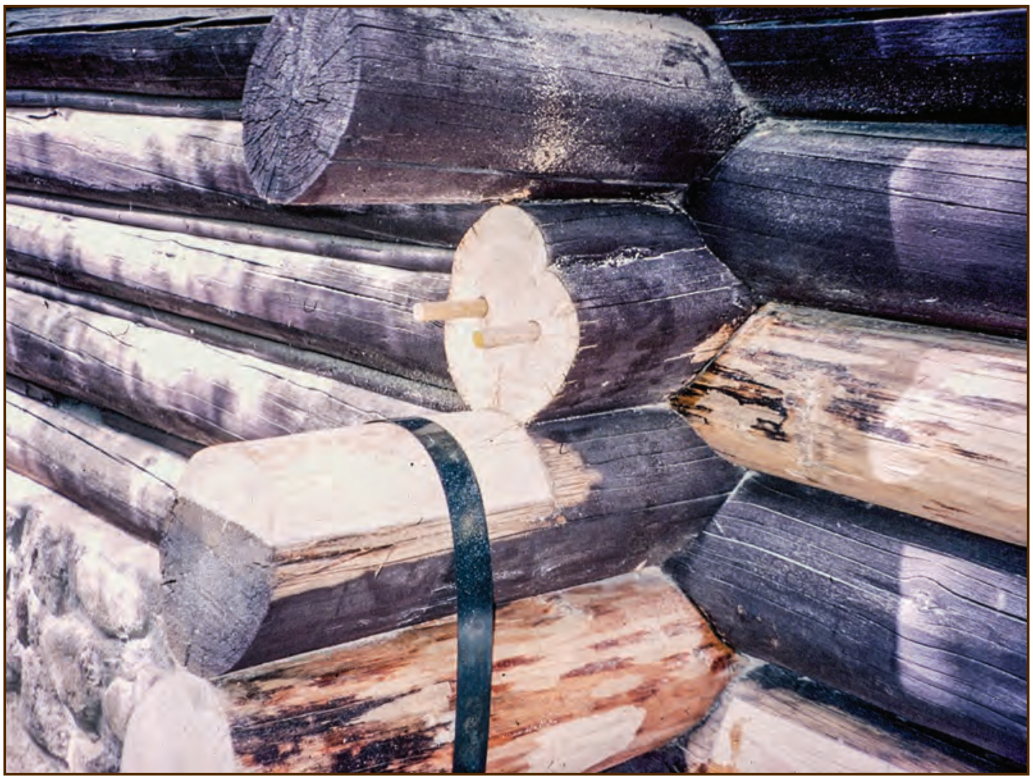


Figure 181—This cabin with battered crown ends required several crown end repairs. Preservation crewmembers have completed two full crown end replacements and a splice and have begun a partial crown end replacement. They have inserted the dowels into the original log and will attach the replacement end next.

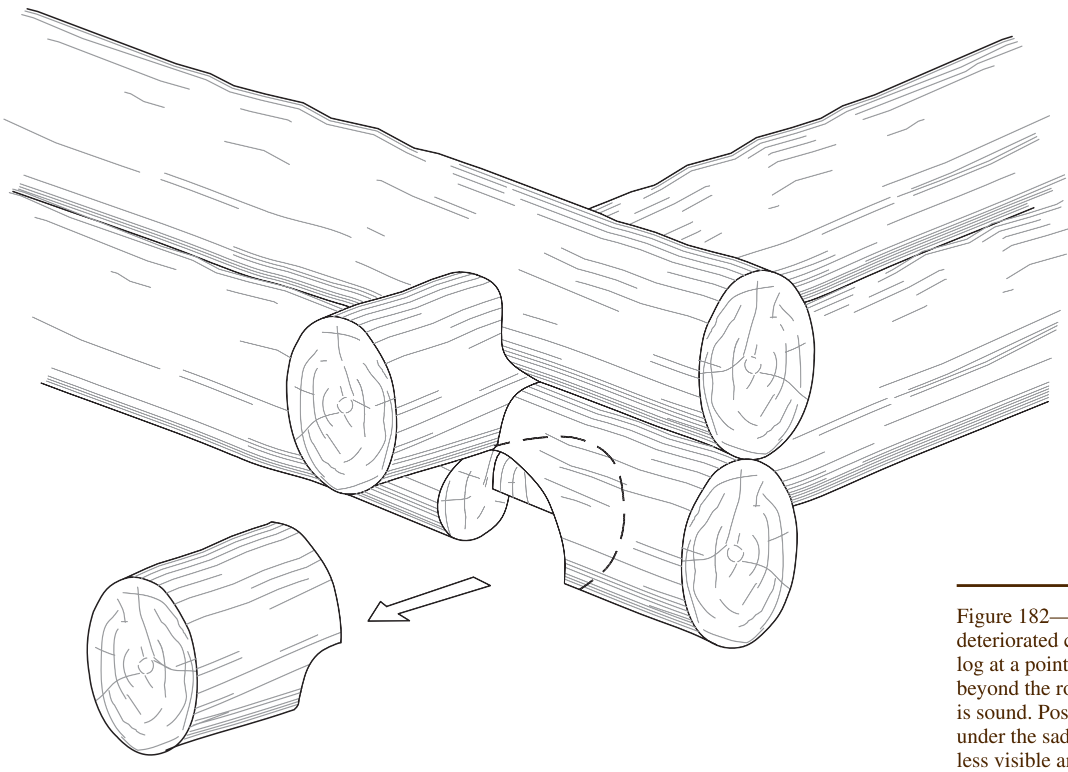


Figure 182—Cut a completely deteriorated crown end off the log at a point a couple of inches beyond the rot where the wood is sound. Positioning the cut under the saddle makes the joint less visible and provides some protection from moisture.

or fiberglass rods with epoxy adhesive and insert them into the holes in the original log. Coat the cut face of the original log and the exposed dowel ends with epoxy adhesive and fit the new crown end in place (figure 183). Clamp or screw the two pieces together until the epoxy dries and then remove the clamps or screws.

To use exposed dowels, coat the cut face of the original log with epoxy and fit the new crown end in place. Clamp, tie, brace, or temporarily screw the two pieces together (figure 184). Ensure that the temporary connection is sturdy enough to prevent the pieces from shifting while you work on them. Drill two diagonal dowel holes that are only slightly larger than the diameter of the dowels through 4 to 6 inches of the replacement crown end and 4 to 6 inches into the original log. Drill one hole from the right side of the log and one from the left side. Coat wooden dowels or fiberglass rods with epoxy and insert them into the holes, similar to doweling an original crown end piece that you removed to access a rotted mid-wall log (see figure 174). Use a rubber or wooden mallet to pound the dowels all the way into the holes. Wipe off any excess adhesive. When the epoxy cures, remove the clamps, ties, braces, or screws and cut any protruding dowel material flush with the log.

Use log screws or lag screws only as a last resort if you cannot use dowels to attach new crown ends. Use epoxy adhesive to attach the new crown end to the original log and then install the screws at an angle up through the underside of the new crown end into the original log above it (figure 185). The author does not recommend using this fastening system because any differential movement between the logs will stress the joint and can lead to failure of the repair.

After you attach the new crown ends, repair the chinking and daubing, as necessary, as explained in the Chinking and Daubing section of this guide. If the original logs are painted, stained, or sealed, apply a matching finish to the new crown ends.

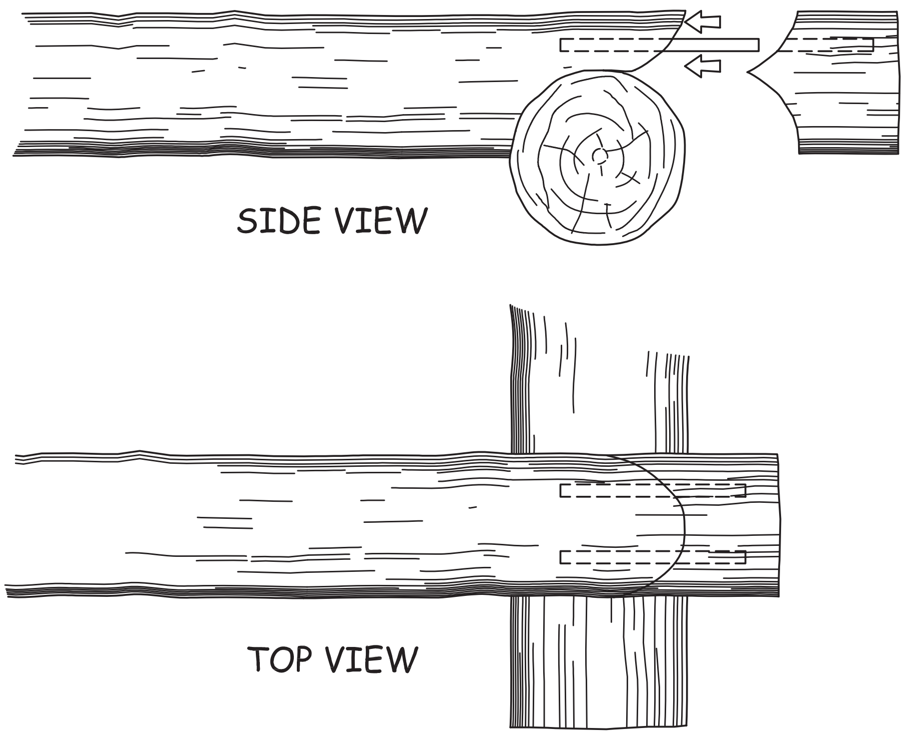


Figure 183—This drawing shows how to use dowels to connect a replacement crown end to the original log.

Figure 184—Kirby Matthew, now retired from the Forest Service Northern Region Historic Preservation Team, drives one of two temporary screws. He's using the screws, a tie board, and epoxy adhesive to hold the replacement crown end in place while he drills holes for the permanent dowel connection.

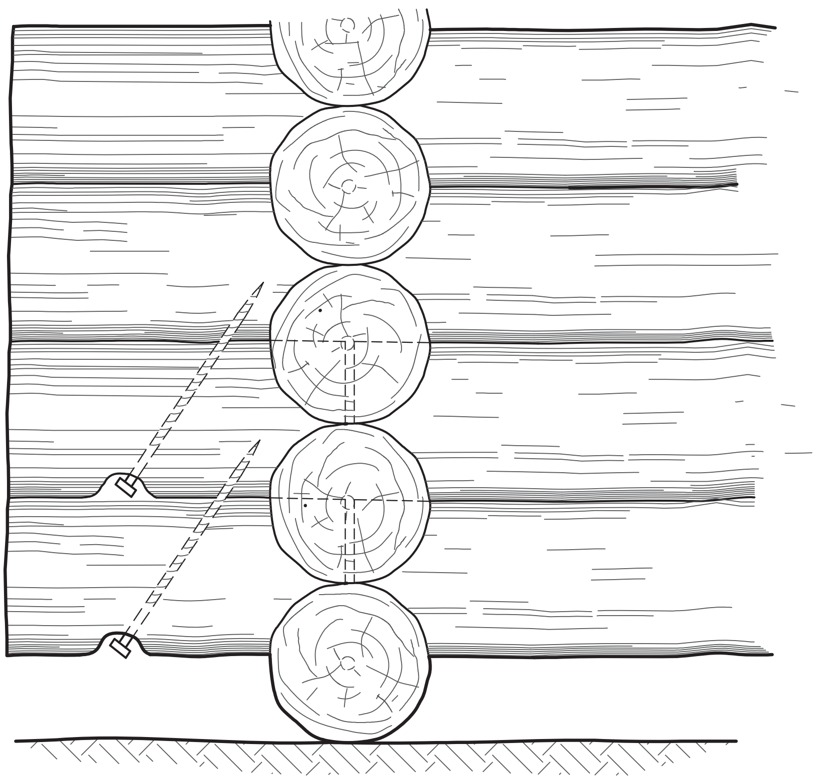


Figure 185—This drawing shows how to use lag screws or log screws to secure replacement crown ends to a cabin. Use dowel attachments if you can. Only use screws if you can't use dowels.

Log Purlin End and Rafter Tail Repairs

Log purlin ends and rafter tails often extend to or beyond the drip edge of a cabin's roof. They are subjected to frequent moisture that leads to rot. You may be tempted to cure this problem by simply cutting off the ends of the logs to minimize their exposure to the weather; don't do it. Removing these ends significantly changes the appearance of the cabin and ruins its historic value. Instead, replace the rotted purlin ends or rafter tails with new purlin ends or rafter tails that match the originals.

Usually, only the ends of the purlins or rafter tails are deteriorated, but sometimes the rot creeps back to the gable log or plate log. Cut the rotted purlins or rafter tails back to sound wood. If the rot extends beyond the gable log or plate log inside the building, you need to replace the whole rafter or purlin.

You probably will have to remove the roofing and sheathing that covers the rafter tails (figure 186) or purlin ends to make repairs. Chances are good that the sheathing is deteriorated, too. If so, don't save the sheathing to reinstall—just replace it after you fix the rafter tails or purlin ends. Likewise, it usually is better to replace the roofing than to try to reuse the old roofing.

After you cut off the rotted end, shape the remaining original log to receive a spliced replacement end. In most cases, use a doweled and glued half lap joint (see figure 160) to connect the spliced end to the original log. Cut the existing log and spliced end so that the lap is about a foot long, if possible. Orient the joint vertically or diagonally to allow moisture to drain out of the repair.

If the rot extends nearly to the gable or plate log, use a modified butt scarf joint (figure 187). A butt scarf joint enables you to replace the top and overhanging end while the sound bottom of the original log continues resting on the gable or plate log. Do not put any loads on the roof while you make this sort of joint; you could overload the bearing capacity of the cut purlin or rafter and cause it to break. After you complete the repair, the roof will support normal loads.

To find and shape a replacement purlin end or rafter tail log, use the techniques described in the Selecting and Preparing Logs, Round Logs, Hewn and Sawn Logs, and Shaping a Log sections of this guide. Use a saw to cut straight joint lines. Finish shaping the joint with a chisel and mallet (figure 188), if necessary.

Figure 186—Preservation crewmembers removed the sheathing and roofing from these rotted rafter tails. The penetration of the awl into one of the rafter tails shows the depth of the rot. The crew will have to remove about a foot from the ends of these rafters.

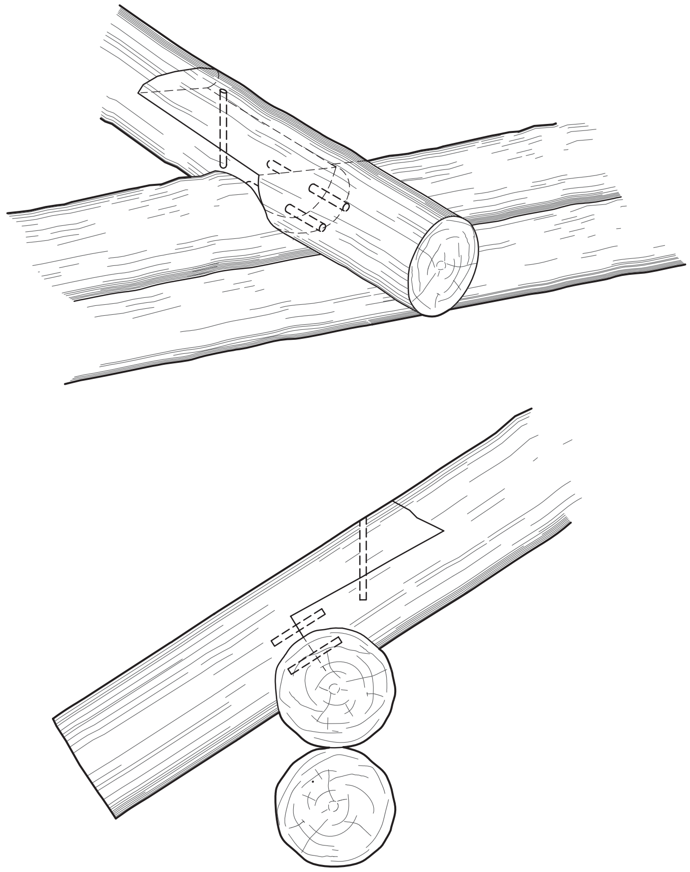


Figure 187—This drawing shows a modified butt scarf rafter tail joint. Hidden dowels join the two pieces horizontally and an exposed dowel joins them vertically. You cover the exposed dowel when you replace the roofing.

Figure 188—A preservation crewmember used a saw to cut the shape for a half lap joint on this purlin end, and a chisel to smooth the face flat.

To attach the new log end, use techniques similar to those explained in the Epoxies and Crown End Repairs sections of this guide. Shaping and positioning the joint is a little different, as shown in figure 189. Insert the dowels perpendicular to the half lap joints (figure 190) rather than angling them, as with crown ends.

When the epoxy adhesive cures, remove the clamps, trim the new log, if necessary, to match the existing rafter or purlin, and cut any protruding dowel material flush with the log (figure 191). If the original logs are painted, stained, or sealed, apply a matching finish to the new spliced purlin end or rafter tail. See the Sheathing and Roofing sections of this guide for information on replacing the sheathing and roofing.

Figure 189—Preservation crewmembers cut these rafter tails to the same pattern to make shaping and attaching the replacement rafter tails easier. They oriented the joints with a vertical splice cut to maximize the strength of the joint and to allow any water that might enter the joint to drain.

Figure 190—This photo shows three stages of rafter tail replacement using a lap joint. On the left, a preservation crewmember checks the fit of the replacement rafter tail. In the middle, the crewmember applied epoxy adhesive to the cut faces of the existing log and clamped the replacement rafter tail in place. On the right, he inserted the glued dowels into the drilled holes.

Figure 191—Preservation crewmembers replaced all the rafter tails on this building. The crew trimmed the dowels flush with the rafter tails, but the dowels still are clearly visible as darker spots. Next, the crew will stain the rafter tails using the same product as the original rafter tails. Finally, they will install new sheathing and roofing.

Chinking and Daubing

Chinking fills the horizontal spaces between logs and daubing is the finish layer that usually looks like dried mud or mortar. People sometimes us the terms interchangeably but shouldn't; these materials have different functions. The author previously mentioned chinking and daubing styles and materials in the Styles: Not All Log Buildings Are Created Equal section of this guide, and explains them more completely in the Chinking, Daubing, and Coping section of Appendix E—Log Building Origins and Styles. Figure 192 shows a number of ways that people have historically filled and finished spaces between cabin logs.

Do not repair chinking and daubing until all replacement logs have seasoned and you've completed all log repairs and replacements and removed all structural jacking and shoring. The only exception to this rule is that you must replace any packing between coped logs as you put the logs into the building. Retain any existing chinking and daubing that remains in good shape after you complete log repairs; repair only what is missing or cracked.

In most cases, replace missing chinking in kind. Usually the original chinking consists of local materials, such as rocks, moss, or leftovers from building the log structure. People sometimes used manufactured materials, such as oakum, for chinking. In some cases, people added chinking after occupying the cabin; this chinking might consist of such household castoffs as newspapers, magazine pages, or fabric scraps. You shouldn't replace this sort of chinking in kind. Replace missing or damaged historic chinking that attracts insects or holds moisture (paper, cloth, moss, clay, and so forth) with oakum to minimize the potential for infestations and rot. Never replace chinking with steel wool; steel wool can be easily ignited by exposure to flame or electrical current and will burn vigorously, especially if the building is struck by lightning.

Use oakum made from lightly oiled hemp or jute fibers for cabin chinking. Oakum eventually will dry out. Replace it when you make log or daubing repairs. Oakum also is an appropriate material for sealing voids to prevent rodent or bat intrusions (figure 193) in historic buildings. Use a stick, putty knife, or slotted screwdriver to push the oakum into voids.

Replace wood chinking with pieces of wood that are of the same species and are about the same size as the original chinking. Remove bark from the chinking unless bark remains on the original chinking. If someone in the past used wood quarter rounds, sticks, or strips instead of or in addition to daubing, the same guidance applies: use wood of the same species and as near to the original size as you can find or make.

Daubing is, by design, the least durable portion of a log building. Log buildings expand and contract a little with moisture and temperature changes, and something has to give. What normally gives is something that is easy to replace: daubing. If you replace daubing with a material similar to the original daubing, the building will function as it was designed to.

Do not replace historical masonry daubing mixes with modern elastomeric daubing materials or with daubing that has a higher proportion of Portland cement than the original. Spray foam and expandable foam aren't appropriate daubing. Commercially available modern daubing products, such as Perma-Chink, Log-Gevity, or Log Jam, also are unsuitable for use on historic log buildings. The color and other visual and physical characteristics of commercial daubing products are incompatible with historic log surfaces. They aren't likely to adhere properly to the old logs and usually fail within a few years.

It's not always possible to replace daubing with the precise material that the builders originally used, particularly if the original was a manufactured material that no longer is available. In these cases, you should replace the daubing with a material that is as similar to the original as possible. For instance, Atco 1821 or 1823 tar in tubes is the most similar material to historic tar daubing available today. Apply it using a caulking gun on a pleasant day—too cold and the tar won't stick, too warm and the tar will run (figure 194). Be prepared to wear a good deal of tar by the time you complete the application.

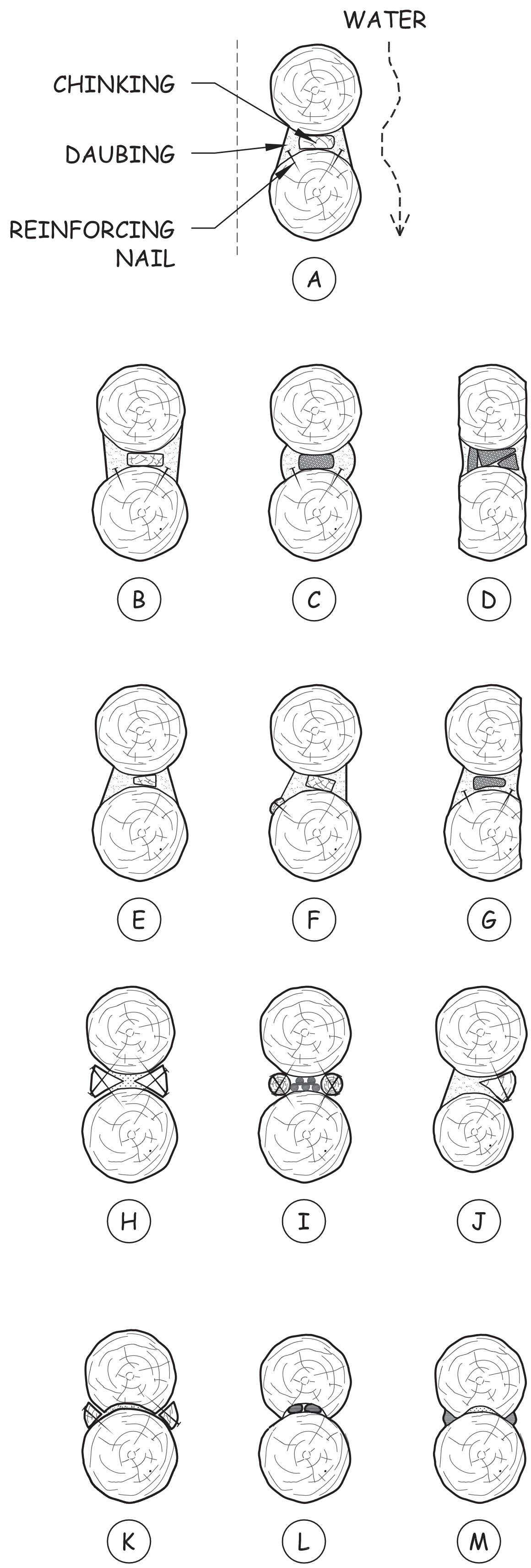


Figure 192—This series of drawings shows many of the ways that people historically filled and finished the spaces between cabin logs. Historic chinking and daubing styles include:

A. The components of typical chinking and daubing. This shows how a well-sealed joint keeps water running down the face of the logs from entering the building, as well as keeping wind, rodents, and bugs out of the cabin.

B. Wood chinking and "struck" style daubing with nail reinforcement on round logs.

C. Stone chinking and "beaded" style daubing with nail reinforcement on round logs.

D. Stone chinking and "flush" style daubing on hewn logs.

E. Wood chinking and "weathered" style daubing on round logs.

F. Wood chinking, "struck" style daubing on one side, and a wood strip on the lower border of the "weathered" style daubing on the other side of round logs.

G. Stone chinking, "flush" style daubing on the hewn side, and "weathered" style daubing on the round side, both with nail reinforcing.

H. Round logs with moss filler between quartersawn poles cross-nailed to the joint.

I. Round logs with oakum chinking between round poles cross-nailed to the joint.

J. Round logs with a quartersawn pole used as interior chinking and as backing for the "weathered" style daubing on the exterior.

K. Coped round logs with masonry filler and small quartersawn poles nailed to the joints.

L. Coped round logs with oakum filler.

M. Coped round logs with moss filler and tar daubing.

Figure 193—Preservation carpenters stuffed oakum into all the spaces between logs in the attic at the Moose Creek Wilderness Station Office/ Cookhouse building to keep bats out. Before crewmembers filled the voids and replaced the roof with shakes over continuous sheathing, several hundred bats occupied the attic each summer, creating an undesirable guano mess.

Figure 194—This worker is using a caulking gun to apply tar daubing between the logs of the Horse Prairie Cabin (Beaverhead-Deerlodge National Forest, Northern Region).

For masonry daubing, use a daubing formula and tooled finish that matches the historic daubing (figure 195). Photos taken during the condition and historic assessments of any areas of original daubing will be valuable tools for matching the color, texture, and configuration of the original. If no one took photos during the assessment but some areas of original daubing remain in place, take several photos now for later reference and be sure to save some sample pieces if you can.

The daubing on some cabins has been patched so many times that it is hard to tell which material is the original. If cabins of a similar age are located nearby, you may be able to examine the daubing for similarities that can provide clues. Older daubing, in general, tends to be a lime mix (rather than a cement mix) using local sand and sometimes other local materials as fillers.

If you don't known the historic mixture, analyze the original mortar daubing so that you can mix the replacement mortar to match the original material as closely as possible. Engage a mortar specialist to conduct a scientific analysis to get the exact ratio of components or do your own rough analysis as explained below.

Mixes typically include lime and sand or clay. Many late 19th- and early 20th-century log buildings contain Portland cement as part of the original daubing. If your daubing is soft, then Portland cement probably is not present. If the daubing is hard, it contains Portland cement. Some mortars include straw or animal hair for reinforcement and crack resistance. Note the color of the sand and other materials. Pure white chunks in the mortar usually are lime. The sand in the original daubing probably came from a local creek or other local sand source. If you can't get the sand from the same source, ask about different sand mixes at your local sand and gravel plant.

Figure 195—The daubing on this Wyoming Game and Fish cabin in Sunlight Basin appears to contain tiny fossilized seashell fragments from the local limestone. To duplicate the appearance of this daubing, you'll need to locate the source and use the same material when you mix daubing for repairs.

To do a rough mortar analysis yourself, you need a handful of daubing. Try to get an intact chunk of daubing that is not weathered. If the daubing is weathered, most of the fines in it probably have leached out, so you won't get an accurate analysis. Crush the daubing to about cornmeal-size particles. Take a good look at the crushed daubing. Identify and record any visible reinforcement fibers or other materials.

Pour the crushed daubing into a straight-sided quart jar with a lid. Add water to nearly fill the jar, screw the lid on firmly and thoroughly shake it. Then, set the jar on a flat surface and wait. The sand settles out first, the binders (lime and Portland cement) stay in suspension for a while, and the fibers may float to the top. After the binders settle and the liquid is nearly clear, determine the ratio of sand to binder by measuring the height of the layers. The lime and Portland cement are so fine that you probably will not be able to figure out the ratio between the two.

When you know the approximate ratio of sand to binders, mix several test batches of daubing based on that ratio and the mortar mix formulas that follow. Experiment with modifications until you find a formula that reasonably matches the original daubing. Be sure to write down everything as you mix and try test batches so that you can duplicate the successful formula. Figure 196 shows the differences in appearance of several mortar formulas containing lime and cement.

You can find the type S hydrated lime in these mortar mixes at hardware or mortar supply stores. Type S hydrated lime products need shorter soak periods before application than other types. Do not confuse hydrated lime, which needs air to carbonate and set, with hydraulic lime, which sets under water. Hydraulic lime rarely is found on Forest Service cabins.

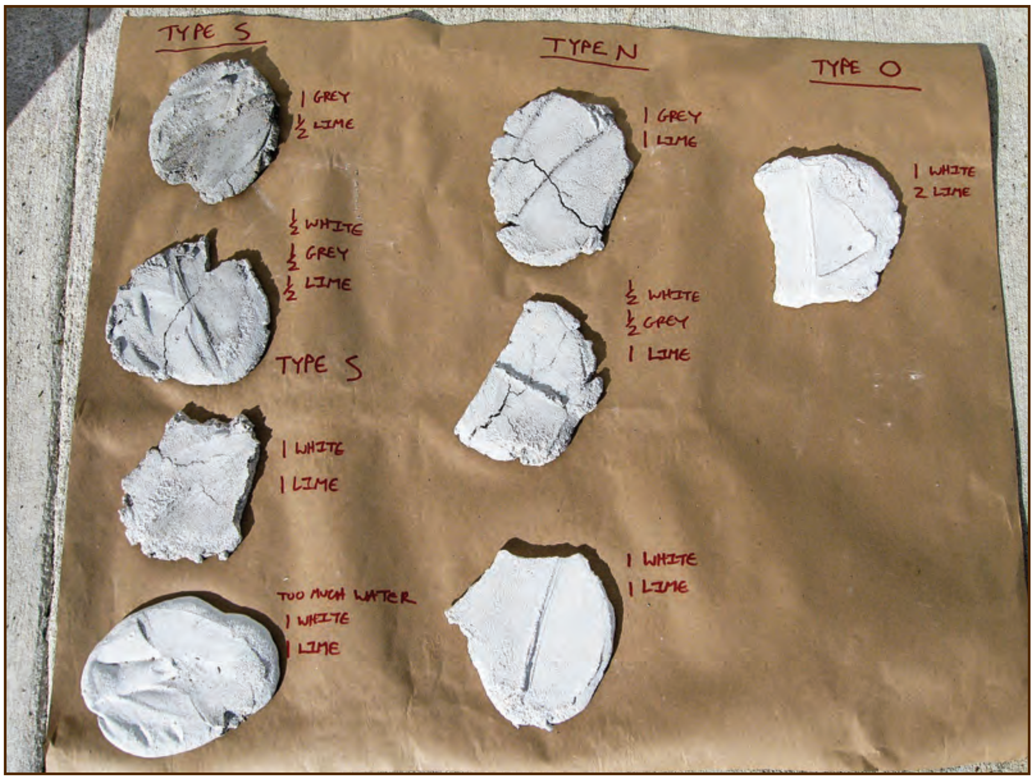


Figure 196—These mortar samples show the difference in appearance when you make mortar using various combinations of lime and white or gray cement. The preservation specialist used the same sand and water for all the samples.

You may add a small amount of Portland cement (for workability) to a lime, clay, and sand mix, but daubing mixes intended for most historic log buildings shouldn't have more than one part Portland cement to two parts lime. Portland cement tends to shrink and develop hairline cracks, retain moisture, and dry very hard, all of which can potentially damage the logs. If the daubing is white, use white Portland cement; if the daubing is grey, use grey Portland cement. Mix grey and white Portland cement together to produce a lighter grey (see figure 196).

Mix several small (about a cup) test batches of daubing to ensure that you have a formula that matches the original daubing. Formulate each test mix with slight variations in the amounts of sand, lime, and, if necessary, Portland cement (figure 197). When the batches dry, crack them open or crush them and compare the interior color, texture, and materials of the test batches to the original. If the insides of the old and new mortar match, the outside of the new mortar will weather to match the old mortar over time. Choose the best match and use that formula to mix a test batch of new daubing. Apply the test batch either on the building or in a mockup elsewhere to test whether the formula's color and texture match the original daubing.

Masonry daubing tools (figure 198) include:

- Pointing, tuck point, margin, and brick trowels
- Hawks
- Paintbrushes, mason's brushes, and wire brushes (wire brushes are used to clean up all the tools afterward)
- Buckets, mud pans, and grout bags
- Spray bottles

For more information about these tools, see Appendix F—Acquiring Tools and Materials.

Mortar Mix Formulas

A. The most commonly used mix in the Northern Region—

- 8 parts sand
- 2 parts lime
- 1 part Portland cement

B. Very soft mix—

- 4 parts sand
- 1 part lime

C. Moderately soft mix—

- 8 parts sand
- 4 parts lime
- 1½ parts Portland cement

D. Moderately soft mix good for use with fiber reinforcing—

- 4 parts sand
- 1 part lime
- ¼ part Portland cement
- Optional fiber reinforcing

E. Moderately hard mix—

- 6 parts sand
- 2 parts lime
- 1 part Portland cement

F. Somewhat harder mix than the moderately hard mix—

- 6 parts sand
- 2 parts Portland cement
- 1 part lime

G. Similar to bagged masonry premix—

- 4 parts sand
- 1 part Portland cement
- ½ part lime

Figure 197—Use a sample board to make it easy to compare test daubing mixes with the original daubing. Write the formula for each test mix on the board with waterproof marker so that you have no doubt about which formula produced which product.

Figure 198—These tools are used for working with masonry daubing. At the top of the photo, from left to right, are a hawk (metal plate with a handle under it, used to hold a supply of daubing while applying it), a hand pump pressurized garden-type sprayer, and a grout bag. The three brushes are, from left to right, a whitewash brush, a mason's scrub brush, and a wire brush typically used to clean tools. The trowels are, from left to right, a brick trowel, three pointing or butter trowels, a ¼-inch tuck point trowel, a ⅜-inch tuck point trowel, a ½-inch tuck point trowel, a 1-inch margin trowel, a 1½-inch margin trowel, and a 2-inch margin trowel.

Use hand trowels to clean out daubing that is loose or that hasn't adhered well to the logs. Leave original chinking, blocking, and fillers intact, but refit loose pieces. You may need to clean out the joint entirely to get a good bond between the daubing and the logs, but that usually is unnecessary. If there was no original chinking and the voids are too large to bridge with daubing, press soft filler, such as oakum (figure 199), firmly into voids with a stick or blunt tool.

The cabin builder originally may have used concealed reinforcement, such as protruding nails, wire mesh, or nailed-on tie wire, to keep the daubing in place. Sometimes builders only used nails on the upper side of the log, sometimes they only used nails on the lower side of the log, and sometimes they placed nails randomly. If you have to replace the reinforcement, use only galvanized nails or wire mesh and follow the original nailing pattern.

Because daubing is a masonry product, do not apply it in full sun, excessive heat, or when you expect freezing temperatures. Just before you mix the daubing, recheck to ensure that the chinking is tight and secure. Then, thoroughly mix all the dry daubing materials. Just before applying the daubing, add water to the dry materials and mix the daubing to a stiff, paste-like consistency. The mix dries quickly, so don't prepare more daubing than you can apply in about 30 minutes.

Spray the area with water just before you apply the daubing. The extra moisture prevents the dry filler from drawing off the moisture within the daubing too rapidly and helps prevent hairline cracking. Use a small trowel to press the daubing into the chinking space and to smooth the filled areas (figure 200). You may need to daub wide or deep chinking spaces or joints in layers to prevent the daubing from sagging and separating from the logs.

Figure 199—This preservation crewmember is stuffing oakum chinking into the gaps between the logs at the Gates Park Guard Station cabin (Lewis and Clark National Forest, Northern Region). After filling the gaps, he will apply the daubing.

Figure 200—This preservation crewmember is using a small trowel to apply daubing to a cabin, carefully matching the profile of the new daubing to that of the original daubing. His hawk is nearly empty of daubing material.

Ensure that the new daubing matches the tool marks and texture of the original daubing. For instance, if the original daubing had trowel marks, use your trowel to mimic those marks. If the daubing had a brushed surface, lightly brush the daubing with a paintbrush or mason's brush to produce the same texture after the daubing sets slightly.

After applying the daubing, respray the daubed area lightly with water to keep the surface from drying too fast. On sunny, hot days, misting with water won't be enough to prevent premature surface drying, so hang a wet sheet or tarp on the wall to shade and moisturize the daubing.

If the daubing cracks as it cures, remove it and start over. This time, mix the daubing and allow it to rest for a few minutes until it sets slightly. The appropriate resting time varies from about 5 to 10 minutes, depending on the outside temperature and humidity. The initial hydration "kick" occurs during the resting time. When the initial set occurs, add a little more water, mix the daubing to the consistency you need, and then apply the daubing. This process is called tempering the mix, and should prevent cracking during the curing period.

Keeping the Rain Out

Every log cabin needs a good roof to keep moisture out of the structure. The foundation, walls, and roof all are important to the durability of a cabin, but if the roof doesn't perform properly, the cabin will soon disintegrate. Use the information in the following sections to help ensure that your roof works properly.

Roofing Safety

For tips on working safely on roofs, refer to the Safety First section of this guide. At a minimum, follow OSHA safety requirements. Do not hesitate to take extra precautions that make you more confident about your safety. Just because people were cavalier about roofing safety in the past or claim to be as sure-footed as a cat doesn't mean that you should take unnecessary risks.

Most roofs are a long way from the ground, and most historic roofs have steep pitches. To protect workers from falls, use scaffolding, temporary guard railings, or a fall-arrest system.

If you use scaffolding, set it plumb and level, ensure that the safety rails are in place, and attach it to the building. If you use a fall-arrest system consisting of a harness, lanyard, rope, and ties to the building, ensure that all the equipment has enough capacity to protect the user, that the equipment is in excellent condition, and that you inspect it daily. Also, follow other safety precautions, such as ensuring that all workers at the site are aware of work being performed on the roof above them, using a bucket on a rope to lift materials and tools onto the roof rather than having workers carry them up a ladder, ensuring that workers do not carry more than they are comfortable carrying, and ensuring that workers always reserve one hand for holding onto the ladder when going up and down. Forest Service employees must follow the precautions in the job hazard analysis.

Using Roofing Jacks and Roof Anchors

As roofers lay courses of roofing higher and higher on the roof, they will no longer be able to work from scaffolding set next to the building and will need to stand on the roof. Use roof jacks, also known as toe board holders or slide guards, to provide a secure surface for the roofers' feet. Roof jacks are brackets that support toe boards. You nail them to the roof through angled slots so you can remove them without damaging the shingles or shakes. Roof jacks are not fall protection. Use rope and harness, lanyard and harness, or properly guarded scaffolding in addition to roof jacks to prevent falls off the roof and serious injury. Follow OSHA requirements and the precautions listed in your job hazard analysis.

To set a row of roof jacks, position each roof jack so that the horizontal bar that holds the toe board is at least 2 inches below the lower edge of the shingle course that will lay above it (figure 201), with the top of the roof jack's nail slots positioned over the gap between adjacent shingles (if possible) and directly over a purlin or rafter. To prevent denting the roofing under the roof jack, place a piece of roofing felt folded double or a spare piece of asphalt roofing between the roof jack and the shake or shingle to provide some cushion.

Place the roof jacks no more than 6 feet apart; that's about as far as a 2x wood plank will span without cracking under the weight of a large person. Drive 16d (pronounced "16 penny") nails through the top of the nail slots, into the gaps between shingles, and through the sheathing into the roof rafters or purlins to secure the roof jacks to the roof. Drive the nails just shy of flush with the roof jacks so that you can remove the roof jacks when you finish using them. The main body of the jack will rest on a just-laid course of shingles, with additional support provided by the course below, the sheathing, and the framing.

Figure 201—This closeup photo shows how roofers set roof jacks on a shingle roof. The chalkline for the next shingle course is above the point where the triangular-plank support attaches to the slotted bar. Notice how the roofers nailed the slotted bars to the purlin through the spaces between adjacent shingles.

Lay planks (2x6 to 2x12 lumber, depending on which width fits snugly into the roof jack) across the jacks and wire or nail the lumber to the roof jacks (figure 202). Install the next course of shingles or shakes, setting a wide shingle over the nail slots of each roof jack. Be careful not to drive any roofing nails within a couple of inches above and to the right of each roof jack or you won't be able to get the roof jack out without cutting the shingles (and then replacing them).

After finishing the roofing job and removing the toe boards, force each roof jack up and to the right so that the slots slide past the nails, freeing the roof jack. Then, slip the roof jack down and out from under the shingles or shakes. For asphalt shingles only, drive the nails flush by carefully hammering on a wood or rubber block positioned directly over the nails that held the roof jacks. This prevents lumps or raised shingles on the roof. Do not attempt to drive the roof jack nails flush on wood shingle or shake roofs. Doing so risks damaging the roofing, which you will then have to replace.

Roofing Anchors

Roofing anchors are secure tie-off points for ropes or straps that connect to body harnesses to form a system that provides fall protection. You can secure either permanent or removable roofing anchors to the roof structure. Anchors for shingle, shake, and rolled roofing typically consist of a D-ring attached to a long metal strap with nail holes. Lay the strap of the anchor with its long dimension perpendicular to the ridge of the roof, directly over a rafter, truss, or purlin, and nail or screw it in place.

If you plan to own the building long enough to be involved in future roofing repairs, consider installing permanent anchor points to make future work easier. In most cases, set permanent anchors close to the roof ridge. The roofing covers all but the D-ring (figure 203). This D-ring placement provides an unobtrusive anchor point. Always follow the manufacturer's instructions for attaching permanent or temporary roofing anchors.

Figure 202—These roofers placed planks on roof jacks, providing a secure surface for their feet during the reroofing of the Moose Creek garage (Helena National Forest, Northern Region).

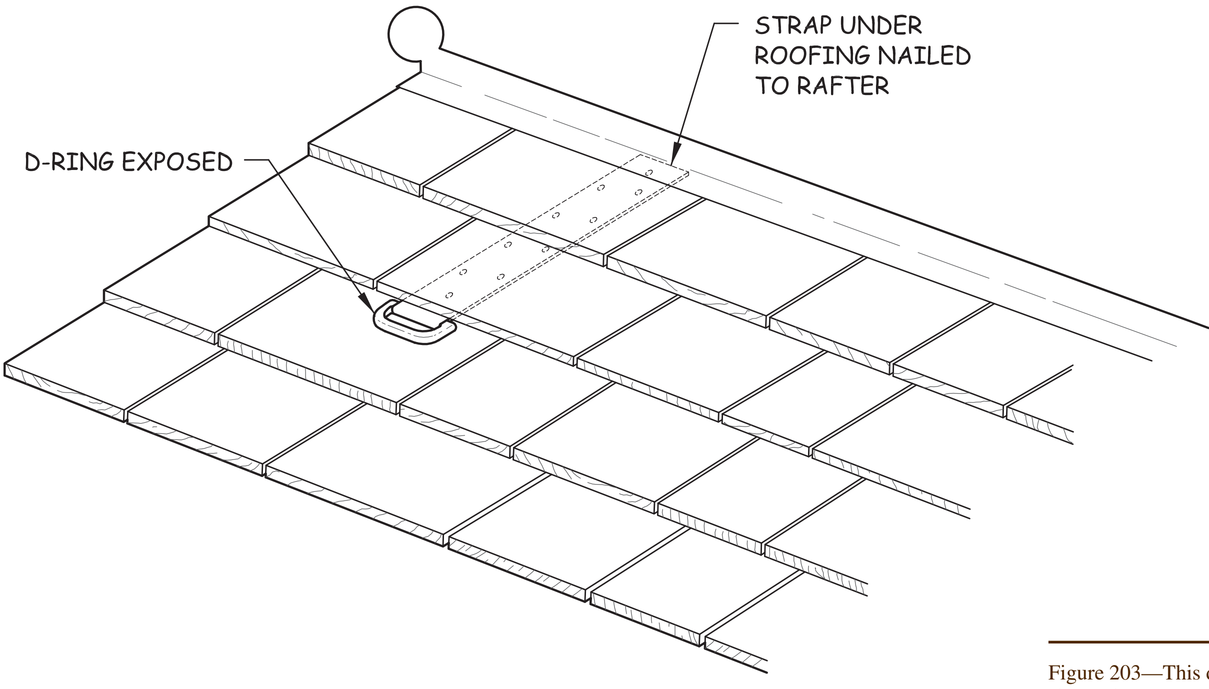


Figure 203—This drawing shows the proper placement of a permanent tie-off point for fall protection.

Rafters, Purlins, and Trusses

The framing that supports the sheathing and roofing on a log cabin may consist of trusses, purlins, rafters, or purlins with rafters. Trusses (figure 204) are complex, usually triangular roof support units that may be constructed of dimensioned lumber, timbers, or round logs. Purlins (figure 205) are logs or timbers that run the length of the cabin and are supported by the end walls and sometimes a center wall of the cabin.

Figure 204—A simple king post truss constructed of logs supports the porch of the cabin at the Stolle Meadow Guard Station (Boise National Forest, Intermountain Region). The cabin has a cedar shingle roof. This photo was taken in 1939, not long after the builders constructed the cabin. The cabin still is in use today.

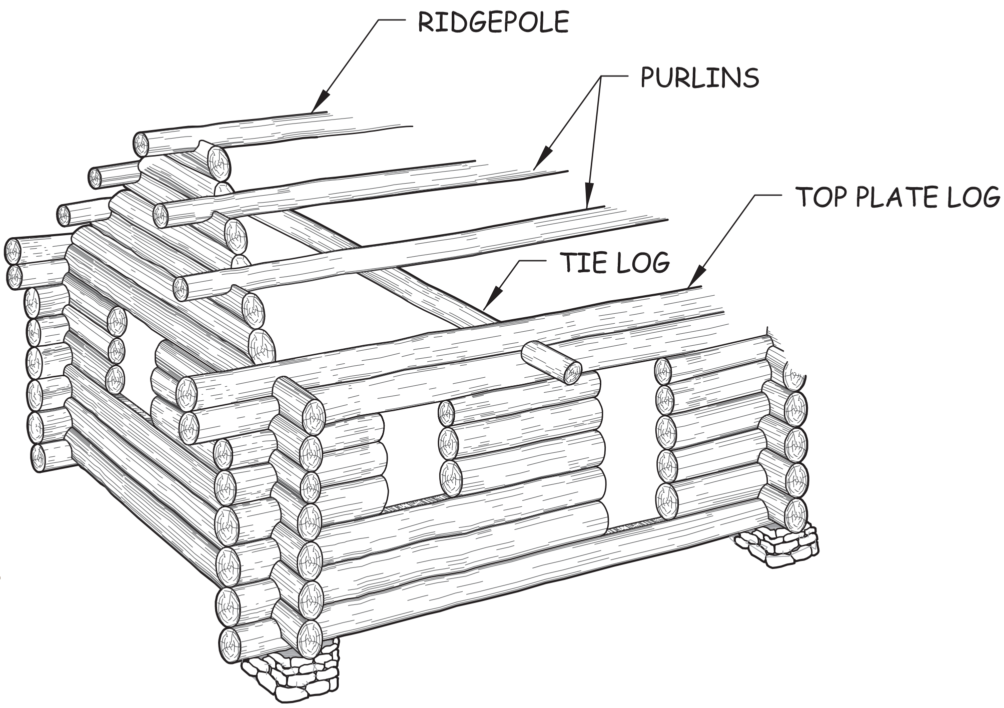


Figure 205—This drawing shows the structural framing of a purlin roof system.

Rafters (figure 206) can be made of logs, timbers, or dimensioned lumber running from the peak to the eave of the roof. The outside walls of the cabin support the rafters. The rafters either brace against each other at the peak of the roof or a ridge beam at the peak supports them. Many rafter roofs need a tie log or tie beams (figure 207) to prevent the weight of the roof from pushing the walls of the cabin outward where the rafters bear on the wall logs. Builders sometimes used rafters and purlins together (figure 208), especially in situations where they could procure only smaller logs or timbers or when they didn't have the resources to lift larger timbers into place on the roof.

Common structural roof problems include underbuilt or undersized lumber or logs, too few or too widely spaced rafters or trusses, connections that have broken or become loose, rotten wood, and inadequate ventilation. Defects in the roof-framing system may show up as humps or dips in the roof. Humps or dips in the roof aren't always because of defects in the roof framing. Foundation, floor, or wall problems that are telegraphed through the structure to the roof may have caused these deformations.

If the building condition and historic assessment identified structural roof problems, review your preservation strategy and project plan to determine what you need to do to fix the problems. Complete any necessary structural design work and use that information to order materials for the repair work. If you didn't complete any of these steps, back off and complete them before you begin repair work. If you don't, you may have to redo your repairs later. Similarly, ensure that the entire building is plumb, level, and square before performing any structural roof repairs. The roof problem may or may not disappear once you realign the building, but at least you won't have to repair the roof structure twice, which may happen if you fix the roof first and address the foundation and other support problems later.

For information about repairing or replacing deteriorated purlin ends or rafter tails, see the Log Purlin End and Rafter Tail Repairs section of this guide. Most other structural roof repairs or structural member replacements are fairly straightforward carpentry work. Select and shape logs using the techniques explained in the Round Logs and Hewn Logs sections of this guide. As with other work on historic structures, select replacement materials that are the same as the materials you removed, or as close to the same as possible.

The SHPO probably needs to review or approve any changes to the roof structure, such as sistering new lumber to old,

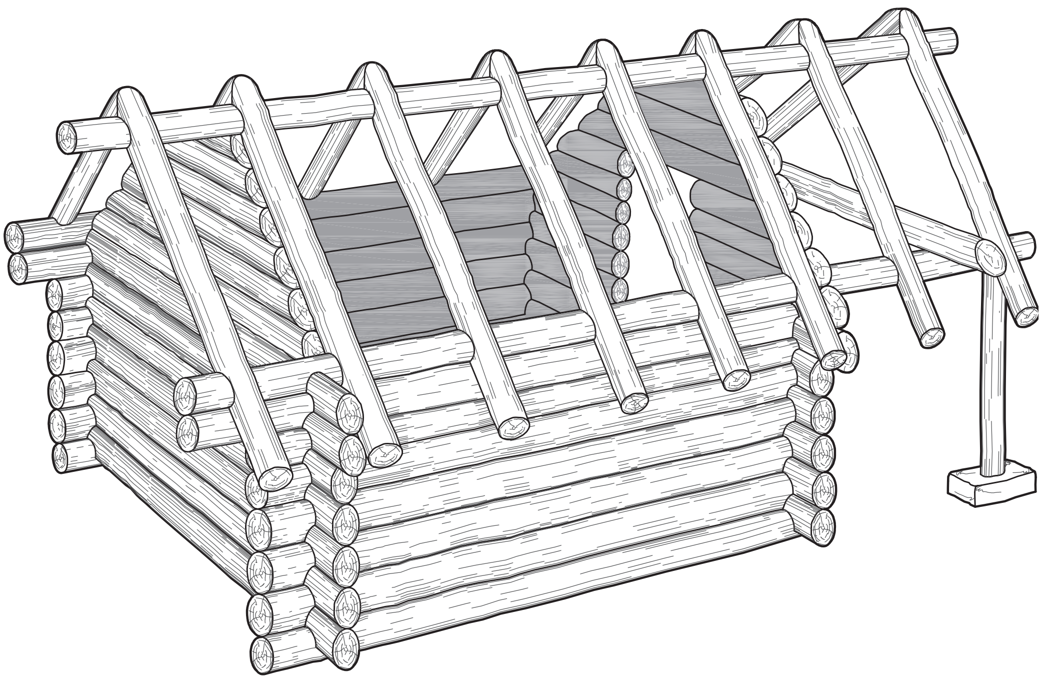


Figure 206—This drawing shows the structural framing of a rafter roof system. Rafter systems may include a ridge beam, shown in this drawing, or may use a simple ridge board that ties the rafters together at the peak of the roof.

adding a knee wall, adding roof vents on gable ends, or adding rafters, trusses, or rafter ties, if a Federal or State government agency owns the cabin, or if Federal or State sources provide some or all of the funding for the cabin preservation work. Check with your heritage resource specialist or archaeologist for the requirements. The local building department also may need to approve structural changes and repairs. You normally can make such repairs as reattaching connections between structural members without getting approvals.

Figure 207—The builders used tie beams (that also served as ceiling joists) on the two-story Steel Creek Barn (Beaverhead-Deerlodge National Forest, Northern Region) to ensure that the walls wouldn't spread apart over time because of pressure from the rafters.

Figure 208—The Liz Creek Cabin (Clearwater National Forest, Northern Region) has a rafter and purlin roof structure. Because of decay, preservation crewmembers removed one of the purlins and the roofing, revealing the framing. They replaced these components before installing the new roofing.

Insulation and Ventilation

Ventilation is very important to roofing durability. Most uninsulated historic cabins had more than adequate ventilation because air moved freely through the walls and roof. These days, people expect more comfortable temperatures, and insulation is part of the solution for temperature control.

If your cabin needs roof insulation, install it between the ceiling of the cabin and the floor of the attic (with an air barrier on the ceiling side) and vent the attic to the outside, unless you have to heat or cool your attic. This will provide plenty of air movement through the attic and no air movement from the occupied space, so there should be no condensation to cause moisture damage.

If you need to add insulation or modern construction materials such as plywood sheathing, air may not circulate as easily as it did with the original construction materials and the building may need additional venting. The general code requirement for venting attics is that the net free ventilating area must be at least $1/150^{th}$ of the floor area of the space to be ventilated. Some code reductions are allowed for installing forced ventilation or vapor retarders. Ask your facilities engineer to check the venting design for functionality and local code requirements. If a Federal or State government agency owns the cabin, or if Federal or State sources provide some or all of the funding for the cabin preservation work, check with your heritage resource specialist or archaeologist to determine whether you must consult with the SHPO to add ventilation that changes the appearance of the cabin.

If you need to heat or cool your attic, you'll need to insulate between the rafters or purlins. Avoid installing insulation tightly to the underside of the roof; it usually leads to condensation-related moisture damage within a few years. This damage is particularly common in air-conditioned structures. If you must install insulation between the rafters, always provide at least 2 inches of ventilation space between the insulation and roof, across the full width between rafters. If the roof has continuous sheathing, provide venting at the eaves and at the ridgeline to minimize moisture formation on the underside of the roof.

Sheathing

Most roofs have a layer of sheathing, sometimes called sheeting, on top of the roof framing. One-inch-thick boards of various lengths and widths butted against each other, shiplap or tongue-and-groove boards, or spaced sheathing boards usually make up sheathing on historic cabin roofs. Spaced sheathing sometimes is called skip sheathing or shingle lath (figure 209). The builders may have laid sheathing horizontally on the roof framing (figure 210), vertically (figure 211), or diagonally (figure 212). Various people may have repaired sheathing many times over the years, using different materials.

If you need to replace some of the boards, look for sheathing materials that match the originals. You may need to custom order lumber to match the size and configuration of the original sheathing to provide an even surface for the new shingles.

Often, the sheathing connects the rafters, purlins, or trusses together and provides rigidity for the roof structure. If you must remove and replace large quantities of sheathing, do the work in sections to avoid possible shifting or collapse of the roof structure. Replacing sheathing boards is fairly straightforward. You can easily copy the original construction methods. Just be sure to take the safety precautions required by your job hazard analysis, which include setting up scaffolding, roping up, and tying off.

People may have replaced the original sheathing with plywood or oriented strand board (OSB) at some point. Plywood and OSB don't allow the roof to breathe as sheathing boards do. You should generally replace plywood or OSB with sheathing boards if you will install historic styles of wood shingles or shakes during preservation. In a few instances, plywood is justified, and the SHPO will most likely approve it's use, even for structures eligible for or listed on the National Register of Historic Places. For example, if the roofing is sod and the framing and sheathing are rotten, you may need plywood as part of an engineered reconstruction of the roof. The SHPO probably will need to review or approve the project, and you will need a structural engineer and a green roofing expert, such as a landscape architect, to properly design the roof.

Some historic cabins didn't have any roof sheathing. Instead, the builders attached shakes or metal panels directly to the purlins. If you are restoring a cabin with no sheathing, you most likely will need longer shakes than are commonly available these days. You can obtain extra-long shakes by special order.

Figure 209—The spaces between the sheathing boards are clearly visible in this photo of the underside of a cabin roof. Roofers added new sheathing boards (lighter color) between the darker color original sheathing boards before putting new shingles on the roof. The shingles are visible in the gaps between sheathing boards. Spaced sheathing often is referred to as "skip sheathing" or "shingle lath."

Figure 210—The roof sheathing on the Moose Creek Station garage (Helena National Forest, Northern Region), built in 1930, is 1-inch-thick boards applied horizontally over the rafters.

Figure 211—The roof sheathing on the Office/Cookhouse building at the Moose Creek Wilderness Station (Nez Perce National Forest, Northern Region), constructed in 1921, is 1-inch-thick by 12-inch-wide boards applied vertically over the purlins. This photo shows the south side of the building.

Figure 212—The sheathing on the one-and-a-half-story Adams Camp Ranger's House, built in 1933, consists mainly of diagonal 1-inch-thick boards with vertical boards at the gable overhangs. The varying widths and colors of the sheathing boards provide evidence of various repairs made over the years. Adams Camp is located in the Salmon River Ranger District of the Nez Perce National Forest in the Northern Region.

Roofing

After you repair the roof framing and sheathing, it's time to repair or replace the surface that sheds the rain. Materials and methods used on historic log cabins varied, depending on what was available locally and on the preferences and abilities of the builders. Common materials included wood shingles (see figure 204), wood shakes (figure 213), metal (figure 214), asphalt (figure 215), or sod (figure 216). People seldom

Figure 213—Roofers used shakes that matched the original roofing to reroof the Office/Cookhouse building (Moose Creek Wilderness Station, Nez Perce National Forest, Northern Region). This photo shows the north side of the building.

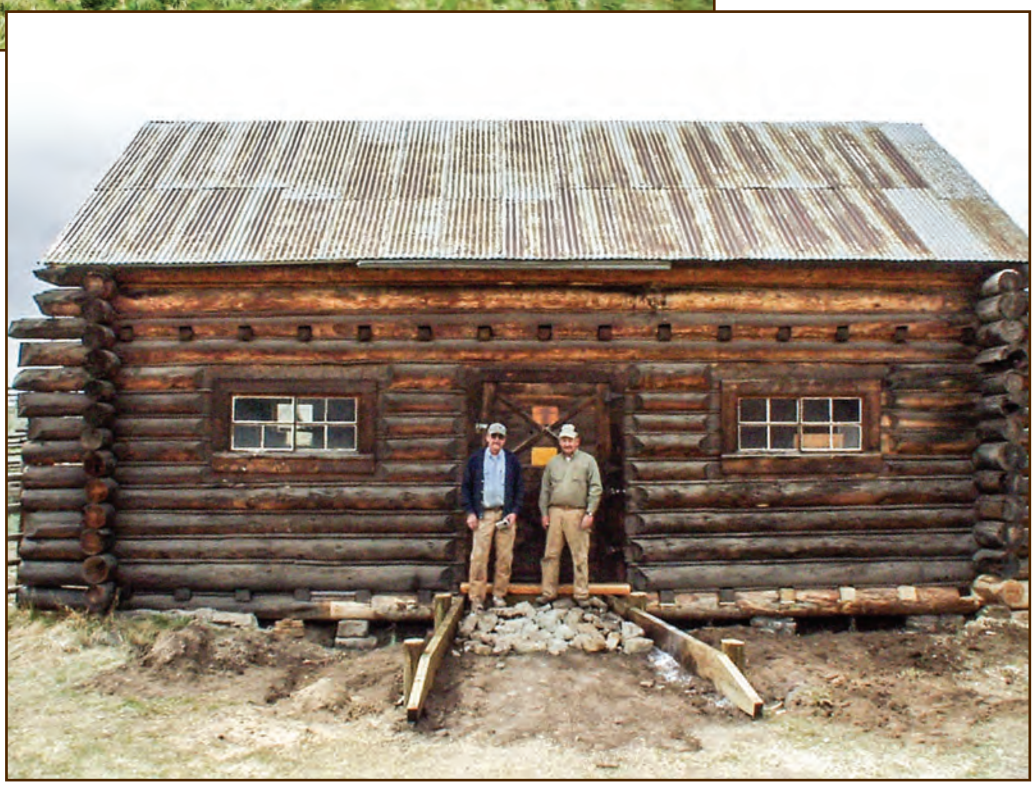


Figure 214—The corrugated metal roofing is original to the Steel Creek log barn (Beaverhead-Deerlodge National Forest, Northern Region), constructed in the early 1900s. Bill Harris and Dale Swee, the now-retired Forest Service Northern Region Historic Preservation Team employees who did the restoration work on the barn, stand in front of the barn door.

Figure 215—This early 20th-century log cabin in Grand Teton National Park has asphalt rolled roofing, just as it did originally. It now houses natural history exhibits.

Figure 216—Rangers H.C. Tuttle and N.E. Wilkerson stand in front of the Alta Ranger Station (Bitterroot National Forest, Northern Region), which they built with a sod roof in June, 1899. Figure 1 shows the stations's modern appearance.

used other materials available in the last few hundred years, such as clay tiles and slate tiles, on log cabins. Tile and slate are very long-lasting but most log cabin builders couldn't afford them. People most commonly used cedar shingles, followed by cedar shakes, in a variety of sizes and shapes, as roofing on log cabins.

The roofing usually wears out long before the rest of a log cabin. Table 2 shows the expected service life for roof materials. Aside from the durability of materials, climate, sun exposure, regularity of cleaning and maintenance, adequacy of ventilation, and building use determine the lifespan of the roofing. No matter the roof material, follow the maintenance procedures identified in the Roof Maintenance section of this guide to extend the life of roofing.

Table 2—Roof Material Expected Service Life.

Roof Material	Years of Normal Service																		
	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95
Sod/Vegetated	■	▲	▲	▲	▲	▲	—	—	—	—	—	—	—	—	—	—	—	—	—
Rolled Asphalt	■	■	▲	▲	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Composition Shingles	■	■	■	▲	▲	▲	—	—	—	—	—	—	—	—	—	—	—	—	—
Cedar	■	■	■	■	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	—	—	—
Metal	■	■	■	■	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	—	—
Tile	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	▲	▲
Slate	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

■ = Minimum service life
▲ = Likely service life
— = Not applicable

You eventually will need to repair or replace your cabin's roofing because all roofing eventually wears out or becomes damaged. Because roof replacement is a normal part of the life cycle of a structure, it isn't necessary to take extraordinary measures to preserve the original roof materials after they reach the end of their useful life. When repair or replacement becomes necessary, use the same kind of roofing originally used on the cabin. Don't "upgrade" to modern or more durable materials that would change the appearance of the cabin.

The inspectors should have included information about the roof material, configuration, detailing, and installation in the historic investigation report. Review the report but, as you begin work, be on the lookout for more evidence about the details of the original roof (figure 217). If you suddenly find evidence that conflicts with the report, stop work until you can determine which evidence is more compelling and more likely to accurately reflect the original construction. Then, use that evidence to match the original materials and workmanship.

Figure 217—This photo shows the remnants of an original shingle label that a crewmember found during restoration work on the Pintler Ranger District's Philipsburg Station (Beaverhead-Deerlodge National Forest, Northern Region).

A Few Words About Wood or Asphalt Roofs and Fire Danger

In areas where forest fires are prevalent, people often are concerned about the flammability of wood shingle or shake roofing and asphalt roofing. People tend to forget that logs also are wood, which means the entire exterior of a log cabin is flammable, not only the roof. Even when a cabin's roofing isn't flammable, sparks and cinders from wildland fires may still ignite the building, especially if the sparks are wind driven or if the cabin has a wood porch.

The author does recognize the danger of fire, but doesn't recommend changing roof materials solely to avoid fire danger. Instead, use effective fire-resistant treatments for wood shingles and shakes that won't affect the visual integrity of the historic building. Although guidance varies from State to State, SHPOs in several States are unlikely to approve changes from the original roofing of historic buildings. Montana and Idaho SHPOs, for instance, prefer applying fire-resistant treatment and protecting structures rather than replacing roofing with different materials. The SHPOs in a few States may approve roof material changes that retain a similar appearance to the original.

Some local building codes may require use of fire-resistant replacement roofing. For example, some jurisdictions require the use of Class B or Class C fire-resistant roof assemblies. In most cases, you can meet these requirements simply by using wood shingles or shakes treated with chemicals or pressure-impregnated salts, or by changing composition roofing to more fire-resistant material that looks similar. You usually can meet the requirements without changing the type of roofing or affecting the visual integrity of the building. Using a fire-resistant treatment when flammability is a concern is always preferable to changing to different roofing.

Constructing a Class A fire-resistant wood shingle or shake roof without changing the appearance of the roof may be more difficult. Class A requires a solid underlayment, and people built many historic cabins with skip sheathing or no sheathing at all. If you require a Class A rating, work with an engineer experienced in designing roofs to ensure that the solid sheathing won't create other problems for the cabin, such as preventing the attic from venting properly. Also, if a Federal or State government agency owns the cabin, or if Federal or State sources provide some or all of the funding for the cabin preservation work, check with your heritage resource specialist or archaeologist to determine if you need to consult with or seek approval from your SHPO.

Pressure treating manufactured wood shingles or shakes with fire-retarding polymers is the most effective and longest lasting fire-resistant treatment. If you must trim pretreated shingles or shakes at the site, check with the manufacturer to find out whether you need to treat the cut to maintain the fire-retardant qualities. While you are at it, be sure to investigate whether additional safety precautions, such as wearing a dust mask while cutting the material, are necessary. You can trim most pressure-treated shingles or shakes without losing the fire-retardant properties.

You can apply fire-retarding chemicals to the surface of the shingles or shakes after you purchase them or after you place them on the roof. To maintain the effectiveness of the retardant, you must reapply surface treatments at regular intervals.

In addition to providing information about fire-resistant treatments, the International Wildland-Urban Interface Code <http://publicecodes.cyberregs.com/icod/iwuic/2012/index.htm> provides guidance for improving the defensible space around a log cabin in case of a fire. Sprinkler systems that operate using water supply lines, cisterns, or a pump in a stream offer another option for roof protection. The sprinkler systems are mostly hidden in the roof framing, with only the sprinkler heads visible. Although the visible sprinkler heads do impact the building's historic integrity, they create a much smaller effect than changing the roof material. Should a fire directly threaten a cabin, you can "wrap" the entire building in foil fabric to protect it (figure 218). The Northern Region has successfully saved structures from wildland fire using these protective measures. In some cases, the trees right next to the cabin burned, but the cabin and the roof did not. Fire can be scary, but isn't necessarily a reason to alter the historic character of a log cabin.

Figure 218—Preservation crewmembers completely wrapped the Kenck Cabin (Lewis and Clark National Forest, Northern Region) with fire resistant material as the 2007 Ahorn forest fire approached. The poles attached to the flues support sprinklers, and the white "ribbons" trailing from the top of the poles are fire hose. The cabin survived unscathed.

Choosing and Obtaining Roof Materials

Locating appropriate replacement roofing can be more challenging than obtaining other materials necessary to restore a log cabin. Changes in manufacturing, consumer preferences, and standard construction practices have combined to change the range of commercially available roof products. The following information explains current, commercially available materials and how to choose those that are appropriate for historic log cabins.

Wood Shingles and Shakes

Wood shake or shingle roofing (figure 219) is a visually important element of many historic log buildings. The variation in shapes and application of this versatile material is amazing and sometimes challenging to duplicate during repairs or replacement. Excellent, detailed information about the historic significance, fabrication, detailing, materials, finishes, repair, and maintenance of historic shingle roofing is available in the National Park Service's Preservation Brief 19, "The Repair and Replacement of Historic Wooden Shingle Roofs," <http://www.nps.gov/tps/how-to-preserve/briefs/19-wooden-shingle-roofs.htm> and isn't duplicated here. The essential thing to remember is that you must find replacement shingles or shakes that match the originals or the roof probably will perform poorly and the roof's appearance certainly will be inappropriate.

People originally referred to any roofing made of overlapping elements as shingles. They usually hand split wood shingles and "dressed" or smoothed them on both faces. Today, people generally regard shingles as a smooth or grooved face, thin butt, sawn product. People generally regard shakes as a thicker butt, hand- or machine-split product with at least one face having a rough, corrugated surface ("undressed"). Some thick-butt, tapered shakes are sawn on both sides. Always match the original materials as closely as possible in size, species, shape, exposure length, attachment pattern and method, and so on.

Figure 219—This log church is still in use and has a recently replaced shingle roof.

Manufactured shingles and shakes made from western red cedar and eastern white cedar are available commercially. You may be able to custom order cypress, red oak, white oak, or other historically used woods. The Cedar Shake and Shingle Bureau (CSSB, figure 220) and the Canadian Standards Association (CSA) set standards for grading and labeling shingles and shakes. Both of these organizations are independent, third-party inspection agencies that provide good sources of information on products, application standards, and specifications. Before purchasing or ordering shingles or shakes, examine samples of the products you are considering (preferably an entire bundle) to ensure that they will work for your particular roof.

Figure 220—This label assures the purchaser that the shingles were graded and labeled in accordance with the standards set by the Cedar Shake and Shingle Bureau.

When ordering cedar shingles, be sure to specify Number One Blue Label shingles (figure 221) certified by the CSSB or CSSIA (Cedar Shake and Shingle Inspection Agency, a division of CSSB) or Extra Grade A Blue Label shingles certified by the CSA. The manufacturers make these shingles out of clear heartwood with very few defects and 100-percent edge grain. Not only are these shingles more durable, they also more closely resemble historic shingles split from clear, old growth timber. Blue Label America Certified shingles aren't the same and their quality isn't as high.

Wood Shingle Length

Commercially manufactured shingles that are sawn on both sides are available in these lengths and designations:

- **16 inches—**Referred to as "Five X," these shingles are 0.40 inches thick at the butt end. This thickness sometimes is referred to as "5/2," meaning that five butts stacked on top of each other measure 2 inches thick. They are the most common size in the Western United States and usually are laid with a 5-inch exposure.
- **18 inches—**Referred to as "Perfections," these shingles are 0.45 inches thick at the butt end. They are the most common size in the Northeastern United States and usually are laid with a 5½-inch exposure.
- **24 inches—**Referred to as "Royals," these shingles are ½ inch thick at the butt end and sometimes are referred to as "4/2." They are more commonly used in the Northeastern United States than in other parts of the country and usually are laid with a 7½-inch exposure.

Figure 221—This label is an example of the sort of label that the manufacturer attaches to shingles that meet the Cedar Shake and Shingle Bureau's Number 1 Grade Blue Label shingles requirements.

When ordering cedar shakes, be sure to specify CSSB- or CSSIA-certified, premium grade because they are clear wood, 100-percent edge grain, with very few defects. They not only are more durable, they also more closely resemble historic shakes split from clear, old growth timber.

If you can't find shingles or shakes commercially that match the size, species, and shape of the original ones on the cabin, you may be able to special order them. Although special orders tend to be expensive, they may be cheaper than the labor it would take to hand-split matching shingles or shakes.

Few people are still skilled at splitting flat or tapered shingles or shakes from a bolt (log section) with a mallet and froe (or axe). The splitting process can be relatively quick, but dressing or planing the shingles on a shaving horse with a drawknife or drawshave is more time intensive. An article on the Mother Earth News website, "The Froe and You: How to Make Hand-Split Shakes" <http://www.motherearthnews.com/Do-It-Yourself/1973-11-01/How-To-Hand-Split-Shakes.aspx> explains the basic method for splitting shakes, if you want to try it yourself.

Finding or making shingles or shakes that are the right length is important for all roofs, but particularly important for roofs where the shingles or shakes attach directly to the purlins. Purlins usually have wide spacing, so you need extra-long shingles or shakes (figure 222) to get the double lap that ensures a leak-free roof.

Types and Lengths of Shakes

Commercially manufactured shakes are available with split faces, sawn faces, or with one split face and one sawn face. Shakes are produced in two thicknesses: medium and heavy. Medium shakes measure ½ inch at the butt; heavy shakes measure ¾ inch at the butt. You also can special order "jumbo" shakes that are 1-inch thick or more at the butt.

- **Tapersawn shakes** are sawn on both sides and come in 18- and 24-inch lengths and in medium and heavy thicknesses.
- **Resawn shakes (sometimes called "Split and Resawn")** are sawn on the reverse side, but the face is split with the natural grain of the wood, providing a highly textured surface. These shakes come in 18- and 24-inch lengths and in medium and heavy thicknesses.
- **Tapersplit shakes** are hand-split shakes made by reversing the bolt, end for end, with each split, so that one end of the shake is thinner than the other. Tapersplits usually are 24-inches long with ½-inch butts.
- **Straight split shakes** are hand- or machine-split shakes split from the same end of the bolt without reversing. They are a uniform thickness the full length of the shake. They come in 18-, 24-, and 36-inch lengths and in medium and heavy thicknesses.

Figure 222—This 1920 storage building at the Greenwood station in the Lolo National Forest of the Northern Region needs extraordinarily long shakes to span the spacing between purlins.

Some cedar roofs have stained shingles or shakes. Dark green is a common color in the Forest Service (figure 223). See the Using Paint, Stain, and Oil section of this guide for more information on staining shingles.

Often, the most distinctive element on a shingle or shake roof is the ridge cap. If the cabin has a metal ridge or hip cap in good condition, remove it carefully so you can reuse it. If it's deteriorated, you probably can find another one that matches the style, or you can have one custom made. If the ridge cap is made of wood boards, shingles, or shakes, copy the existing pattern.

If you're not sure whether the existing ridge cap matches the original, investigate to determine the original ridge cap type, exactly as you would for any other part of the cabin. If the condition and historic assessment doesn't identify the original type of ridge cap, have your heritage specialist or archaeologist help you determine what is appropriate.

Common Ridge or Hip Cap Styles

- **Cock's Comb—**Leave wood shingles or shakes high on one side of the ridge (figure 224).
- **Board—**Lay two overlapping boards along the ridge (figure 225).
- **Metal—**Use a premanufactured piece; often has a ball or other finial on each end (figure 226).
- **Shingle or Shake—**Lay the overlapping shingles or shakes sideways at the ridge or hip of the roof (figure 227).

Figure 223—The 1941 Big Creek Ranger Station (Payette National Forest, Intermountain Region) has green-stained shingles. The color is original to the building. This building is on the National Register of Historic Places.

Figure 224—The cock's comb ridge cap is clearly visible on the skyline of the newly reroofed Office/Cookhouse building at the Moose Creek Wilderness Station (Nez Perce National Forest, Northern Region).

Figure 225—Roofers used boards to construct the ridge cap on this log cabin with a shingle roof north of Lander, WY. *Photo © Andrew Gulliford; used with permission.*

Figure 226—Builders commonly used metal ridge cap on early 20th-century buildings, including log cabins. This photo shows the original metal ridge cap, which preservation crewmembers carefully removed and reinstalled after they replaced shingles on this building at the Ninemile Ranger Station (Lolo National Forest, Northern Region). Most of these premanufactured metal ridge caps had ball-shaped trim on each gable end, as shown here.

Figure 227—The shingle hip cap shown in this photo is a common style used on square, shingle-roofed lookouts in the Northern Region.

Asphalt Roofing

If a historic cabin originally had an asphalt roof, it probably was rolled asphalt roofing (figure 228). Some log cabins built in the 20th century had Dutch lap, interlocking (figure 229), or straight-laid individual shingles, or even three-tab or hexagonal strip shingles. You can find more information about identifying, caring for, and replacing 20th-century asphalt roofing in the publication "Early 20th-Century Building Materials: Siding and Roofing" <http://www.fs.fed.us/eng/php/library_card.php?p_num=0873 2308P>.

Asphalt rolled roofing and asphalt shingles currently are available with an organic base or a fiberglass base. Organic base products have been around since the late 1800s, and builders still prefer them in some parts of the country because they are more flexible and easier to install in cold weather.

Figure 229—This cabin has an interlocking asphalt shingle roof. Builders have used this interlocking pattern since the late 1920s and still commonly install it on new buildings, particularly in high wind rural areas, because of its wind resistance. An interesting detail on this roof is the bent-over shingles at the roof eaves that function as a sort of inexpensive, integral drip edge.

Figure 228—Builders constructed Hogback Cabin (Lolo National Forest, Northern Region) between 1913 and 1915 using rolled asphalt roofing. They used metal flashing all around the dormer and at the transition between the main roof and front porch roof.

Fiberglass base products have only been available since the 1960s. Builders prefer them in some parts of the country because they are available with a Class A fire-resistant rating. Most manufacturers make shingles that meet ASTM D3462; a tear-resistance test. Avoid the cheap shingles that don't meet the ASTM standard.

Because shingles with organic bases and fiberglass bases look nearly identical, choose shingles with a fiberglass or organic base, depending on your desired performance characteristics. Manufacturers coat both types of shingles with tiny stones, flyash, or ceramic-coated granules, which give the roofing its color. Match as closely as possible the color and pattern of the replacement asphalt roofing with the historic roofing.

Metal Roofing

Historic metal roofing may have been made of tin- or terne-plated iron, aluminum, galvanized steel, or copper. Some early miners even roofed cabins with flattened tin cans. Miners used tin and steel more often than other metals because these materials were cheaper and more readily available.

Metal roofing has long been available in a variety of styles, including standing seam, corrugated (figure 230), ribbed panels in a variety of patterns, and shingles that resemble wood shakes, slate, or ceramic tiles or that have decorative patterns. Ensure that replacement or repair materials match the appearance of the original metal roof, even in small details, because pitched roofs are easy to see. For instance, the spacing of the roof seams on a standing seam metal roof is a big factor in maintaining the appearance and historic integrity of the building.

Some currently available metal roof products are the same as or very similar to products that builders have used for more than 100 years. You can special order other historic patterns. Unfortunately, some older metal roofing shapes and patterns no longer are available. Patterned shingles are the hardest historic metal roofing to match. Roofing with the same patterns is unlikely to be available today. Unless you can salvage identically patterned shingles from another building, you will need to have replacement roofing specially manufactured. Fortunately, builders seldom roofed log cabins with fancy patterned shingles.

If you can't find the exact material of the historic roof, you may find a similar pattern with a similar appearance in a different material. You probably can use lead-coated copper, terne-coated steel, or zinc-coated steel with a matching profile to replace tin, terne plate, zinc, or lead. Remember that you can absorb lead through your skin and it can cause serious health problems. Information about working safely with lead is available in the Forest Service Facilities Toolbox section on lead roofing and flashing <http://www.fs.fed.us/eng/toolbox/haz/haz22.htm>.

If you can no longer obtain the historical metal roof shape, material, or pattern, you may need to consult with the SHPO to determine an appropriate substitute roof material. Check

Figure 230—This fancy log house has corrugated galvanized steel panel roofing. Roofers used matching galvanized steel ridge covers on the pyramidal second floor roof.

with your heritage resource specialist or archaeologist about consultation or approval requirements if a Federal or State government agency owns the cabin or if Federal or State sources provide some or all of the funding for the cabin preservation work.

Although table 2 shows a wider range, you can expect most metal roofing available today to last 40 to 60 years if you install and maintain it properly. Painted finishes on metal roofing, unless they are very high quality, may not last anywhere near that long. If the metal roof requires a colored coating and you want it to be durable and color stable, specify powder-coated paint with polyvinylidene fluoride (PVDF).

Most manufacturers design fasteners, clips, corner pieces, and other components of metal roofing to integrate only with a single, specific roof product or with products produced by a specific manufacturer. Always use the manufacturer's recommended fasteners and methods of fastening. Not using the recommended components and methods may invalidate the roofing warranty. Unless the roofing manufacturer recommends otherwise, always use self-tapping, metal-to-wood roofing screws with gasketed flanges if the fasteners remain exposed to the weather. Gasketed fasteners remain leak tight even when the fastener holes enlarge over time because of normal wear from thermal expansion and contraction.

If sustainability is important to your preservation project, consider specifying nanotechnology solar reflective coatings for a "cool" roof. These coatings generally cost only a little extra and provide longer lasting thermal protection than other types of thermally protective roof coatings.

Sod and Vegetated Roofs

Sod roofs are exactly that—a layer of soil supporting grass growing on the roof. People have used sod roofing in one form or another for thousands of years (figure 231). Even primitive sod roofs had surprisingly few leaks, because they tended to be quite thick and because the old-timers knew it was critical to install a drainage layer of some sort under the soil. Drainage layers usually consisted of organic material, such as birch bark or heavily oiled or waxed sturdy fabric. These layers eventually rotted, so they had to replace the entire roof on a regular basis.

Figure 231—The little log assay office at Virginia City, MT, has what the builder probably intended to be a sod roof. It appears that someone tried to replace the roof and wasn't entirely successful; rather than grass, the thin soil on the roof mostly supports weeds. This roof needs some work, including replacing the soil with higher quality soil or growth media and some good native grass seed. Asphalt building paper that someone applied as a drainage layer is visible on the gable end of the cabin. The round poles surrounding the roof hold the soil in place.

The ongoing expense of replacing historically accurate sod roofing means it probably isn't reasonable for you to replace sod roofing exactly as originally constructed for most buildings. You may be able to provide nearly the same appearance using a modern, long-lasting sod or other vegetated roof system. The two key components are drainage and waterproofing.

You can construct a vegetated roof that will last a long time and not leak if the roof is well designed and you execute the details properly. A proper design by a structural engineer and a green roofing expert, such as a landscape architect, is essential. You may need the SHPO to provide prior input or approval of the design if a Federal or State government agency owns the cabin, or if Federal or State sources provide some or all of the funding for the cabin preservation work. Check with your heritage resource specialist or archaeologist for the requirements.

Roofing Repairs

If sudden, dramatic damage occurs to an otherwise sound roof, such as a large branch being driven through the roof during a storm, repairing just that area may keep the roof functional for another 10 years or more. Most roof repairs tend to be a stopgap measure performed on deteriorating roofing that postpones roof replacement only for a little while. For instance, plastic roofing cement or asphalt roofing tar can temporarily repair isolated small holes or cracks. However, those holes or cracks usually indicate that the roofing is beginning to wear out and that it's time to replace it. Following are a few repairs that may stop the leak and allow you to postpone roofing replacement until a more convenient time.

In instances where a few shingles or shakes are cracked or the vertical joints of overlapping shingles or shakes are aligned and water is leaking into the building, slip a piece of metal flashing beneath the shingle to stop the leak temporarily. You can temporarily stop leaks and prevent damage to the cabin using patches of roofing tar or rubber roofing membrane sealed with roofing tar. These patches won't last more than a few months in severe climates or a year in mild climates. Permanently repair the leak or replace the roofing as soon as possible.

You can replace individual cedar shingles on roofs and walls. First, remove the broken shingles. Try to gently pull out the broken shingle without disturbing the adjacent shingles. If pulling doesn't work, use a utility knife, chisel, or roofing hammer to split the damaged shingle and pull the split pieces out with pliers. If the shingle still won't come out, reach up under the broken shingle with a roofer's saw or a shingle ripper (figure 232) to sever the nails holding the shingle in place.

Figure 232—You can slip a shingle ripper (left) up under a shingle and around a nail, then hammer down sharply to cut the nail. You also can slip a roofer's saw (right two) under a shingle and use the tiny teeth to saw the nails. Either tool will sever roofing nails so that you can remove individual shingles without damaging the surrounding shingles.

People sometimes call a shingle ripper a shingle-ripping bar, slater's ripper, shingle nail cutter, or nail puller. To use it, slide the head of the nail cutter gently up under the shingle using a little leverage to raise the shingle slightly. Then, move the head of the cutter around to catch the nail in the cutting fork. Cut the nail using a hammer or mallet to give the bent handle end of the cutter a sharp blow in the direction of the downward roof slope. A shingler's saw accomplishes the same thing and requires less skill, but it will take longer to saw through the nail. With practice, you can cut the nails and remove the shingles without damaging adjacent shingles.

When you've removed all the shingle pieces, find a matching replacement shingle. Tap the shingle most of the way into place, stopping when the butt is about ¾ inch shy of flush with the adjacent shingles. Hammer two nails ½ inch in from the opposing edges of the shingle and as close to the butt of the shingle above as you can without damaging the shingle above (figure 233). Protect the butt of the new shingle with a wood block and tap the block to drive the shingle the rest of the way into place, flush with the adjacent shingles.

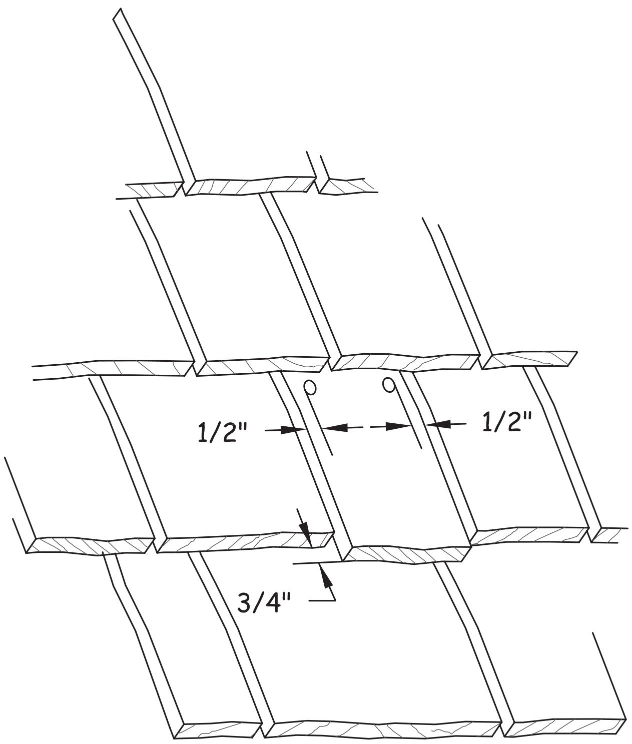


Figure 233—This drawing shows how to space the nails when you install a replacement wood shingle.

You can replace damaged individual asphalt shingles and often can cement curled asphalt shingles back in place. Because asphalt shingles crack easily in cold weather and are easily disfigured and scuffed in hot weather, only install asphalt shingles when the temperature is between 40 and 85 °F.

To replace an individual shingle, first slip a pry bar or stiff putty knife between the damaged shingle and the shingles above and below it to break the tar seals that hold them together. Very carefully lift the shingle above the damaged one to expose the nails or staples holding the damaged shingle in place, remove the fasteners and then remove the shingle. Do not attempt this method in cold weather and be careful not to bend the shingle too far or it will break. Remove the plastic guard from the tar seals of the replacement shingle and slip it into place, then nail or staple it. Apply a dab of roofing cement across the top of each new nail head or staple. The tar seals on the new shingle will adhere to either the shingle above or below it, depending on how it was manufactured. Apply a few dabs of roofing cement between the new shingle and whichever adjacent shingle won't adhere with the tar seals. Press the shingles carefully and firmly together to create a good seal.

You can replace metal roof panels and rolled asphalt roofing in kind. If the rest of the roof is sound, replacing a damaged section of roofing can be a fairly straightforward repair. Replicate historic fastening and material patterns to maintain the visual integrity of the building. Do not use modern or "standard" methods or patterns—stick with what already is in place.

When repairing a roof, do not allow sustained contact between materials that are physically or chemically incompatible with each other. The materials will react and cause accelerated deterioration or corrosion. For example, do not use steel screws to fasten aluminum roofing because steel and aluminum are incompatible materials.

If 20 percent or more of your cabin's roofing is damaged or worn out (figure 234), don't try to repair it. Replace it. Obvious signs of deterioration include cupped, curled, or broken shingles or shakes, missing portions of roofing, loose or missing fasteners in metal roofing panels, exposed sheathing, and leaks.

Figure 234—More than 20 percent of the shingles on this roof are worn out or damaged, so you should replace the roofing.

Planning and Preparing for Roofing Replacement

Before buying the materials necessary to replace the roofing, you need to do a lot of measuring and a little math. If you're not good at doing math in your head, a calculator is useful. Write down the numbers you come up with so you can use them later. You easily can determine how many square feet of roofing you need by measuring the length and width of the roof along the slope, then multiplying the length by the width. Do not forget to add in the roofing for small sections, including any ells, dormers, cupolas, etc.

You also need to determine the pitch (steepness) of the roof because some roof materials aren't suitable for flat or very steep roofs, and because the fastening requirements for some roofing differ depending on pitch. The pitch is a ratio of the rise to the run (figure 235) and is always expressed as the inches of rise in 12 inches of run.

You easily can determine the pitch if you have a pitch finder or framing square. Using the pitch finder is simply a matter of aligning it with the roof pitch and reading the dial.

To use a framing square to determine pitch, level the long arm and hold it against the gable end of the roof so that it crosses the roofing at "12" on the scale. To determine the amount of rise, read the scale on the short arm where it crosses the roofing.

You also can use a speed square and a bullet level if the cabin has gable end fascia or dimensioned lumber rafters more than 8 inches deep. To use a speed square to determine pitch, first mark a plumb line on the rafter or fascia. Place the right angle corner of the square at the point where the bottom of the rafter or fascia and the plumb line intersect. Align the leg marked in inches with the plumb line. Make sure the other leg points toward the center of your end of the cabin. The pointing end will be below the edge of the fascia or rafter. If it's not, flip the square over. Read the rafter scale ("COM-MON") where it intersects the bottom of the rafter or fascia.

If you don't have any of these handy tools, dig out your tape measure and some scratch paper. Measure and record the rise (the vertical measurement) and the run (the horizontal measurement) of the roof (see figure 235). To determine the amount of rise in 12 inches, multiply the rise by 12 and divide by the run. Be sure to measure the rise and run in the same units; inches, feet, or even metric will work.

To understand why this works, remember the basics of high-school algebra to solve the equation:

rise ÷ run = X ÷ 12, where X is the pitch

Before solving the equation, convert it to:

X = (rise x 12) ÷ run

For instance, consider a cabin where the pitch of the roof rises vertically 3 feet 4 inches (3.33 feet, or 40 inches) over a distance of 10 horizontal feet (120 inches) from the eave to the peak. To solve the equation in inches, use:

40 x 12 = 480, and 480 ÷ 120 = 4

If you solve the equation in feet, it comes out the same:

3.33 x 12 = 39.96 (round to 40), and 40 ÷ 10 = 4

Thus, the pitch of the cabin roof is 4/12 (spoken as “4 in 12”).

Discuss the size and pitch of the roof with the roofing supplier. The supplier can give you information to help you determine how much roofing you need, which type of fasteners to use and how many, which underlayment product the manufacturer recommends, etc.

Do not forget to purchase enough of the correct fastener. Cedar shingles and shakes require corrosion-resistant roofing nails (stainless steel type 304 or 316, hot-dipped zinc coated, or aluminum) that are long enough to extend through all layers of shingle and three-fourths of the way into the sheathing. Fasten pressure-treated wood shingles or shakes with stainless steel shingle nails. Stainless steel nails resist corrosion from the pressure-treatment chemicals. For metal roofs, follow the manufacturer’s recommendations. If the manufacturer has no recommendations, use self-tapping metal-to-wood roofing screws with gasketed flanges. See the Roofing Fasteners and Tools section of this guide for more information.

Manufacturers pack shingles and shakes in bundles and market them by the square. A square covers about 100 square feet of roof. When you estimate how many bundles or squares to order, add 1 extra square for every 100 linear feet of valley. Then, add 20 percent to the total for the ridge cap, the triple starter course, wasted shingles or shakes, etc. A square of wood shingles or shakes contains four or five bundles and a square of composition shingles contains three or four bundles.

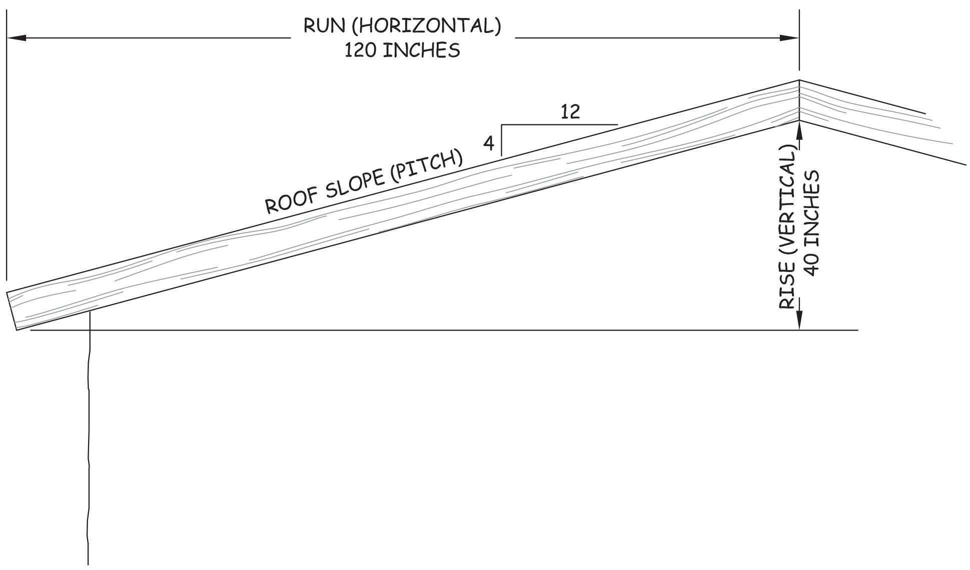


Figure 235—This drawing shows the relationship between the horizontal and vertical measurements of a roof and the pitch of the roof.

After assembling the new roof materials and ensuring that the safety system is in place, remove the existing roof down to bare sheathing (see figures 210, 211, and 212). Shingle rippers, pry bars, flat-bladed shovels, roofing spuds, roofing shovels, and hammers are useful for removing shingles and shakes (see figures 57, 59, and 232). If the cabin doesn't have sheathing, remove everything down to the purlins. Remove all the nails and other fasteners. By the time you need to replace roofing, the flashing usually is pretty beat up, too, so remove that as well. See the Flashing section of this guide for more information.

The builders may have used lead as flashing around chimneys or vents in the roof. Lead is an excellent flashing material that builders still use today, but you can absorb it through your skin and it can cause serious health problems. Information about how to work safely with lead is available on the Internet in the Forest Service Facilities Toolbox section on lead roofing and flashing <http://www.fs.fed.us/eng/toolbox/haz/haz22.htm>. You can reuse lead vent and chimney flashing if it is in good shape.

Once you expose the sheathing or purlins, examine the roof structure and repair or replace any rotted sheathing boards (figure 236), fascia, purlin ends, rafter tails, and holes. See the Sheathing section of this guide for more information about how to repair sheathing. See the Log Purlin End and Rafter Tail Repairs, Epoxies, Crown End Repairs, Selecting and Preparing Logs, Round Logs, Hewn and Sawn Logs, and Shaping a Log sections of this guide for more information about repairing or replacing log structural members.

If the roof has sheathing, use a broom or leaf blower to clean it. Make sure that you remove any raised or loose nails. Standing and working on clean sheathing is safer and easier. In addition, lumps between the sheathing and roofing cause most roofing to perform poorly, and loose or protruding items are likely to puncture the roofing and cause leaks.

Figure 236—This old photo shows a preservation crewmember planing a replacement sheathing board so that he can fit it properly on the log Ranger Cabin at Big Prairie Work Center (Flathead National Forest, Northern Region). All the rafter tails and the sheathing attached to the tails on this side of the cabin, built in 1933, were rotten; the preservation crew had to replace them.

Underlayment, Ice and Water Shield, Drip Edging, Rakers, and Cant Strips

After you strip and repair the roof, prepare the surface to receive the roofing by installing any required cant strips, underlayment, ice and water shield, drip edging, and raker shingles. You must accomplish this work in the proper order so that the roof functions properly. Do not add anything to improve the function of the roof that will be visible on the edges of the roof; it will change the appearance of the cabin and won't be appropriate to the building.

Cant strips (figure 237) are triangular boards used to ease the transition between a vertical element, such as a dormer, and the drainage pitch of the roof. Cant strips help guide water away from vertical surfaces, such as dormer walls, and also provide support for felt or ice and water shield that bends up the vertical surface under the flashing or for roofing that bends up the vertical surface. If the builders originally used cant strips, install the replacement cant strips before installing the underlayment.

Next, lay the underlayment, if you need it. The builders of most historic log cabins constructed before the mid-1800s attached roofing directly to the purlins or sheathing. In contrast, most builders who constructed cabins after 1900 included a layer of asphalt felt roofing paper between the sheathing and roofing. Do not install underlayment if the sheathing isn't continuous, except in the case of interwoven underlayment with shake roofs on skip sheathing, as explained in the Reroofing With Wood Shakes section of this guide.

Some roofing manufacturers recommend ice and water shield in areas with harsh winters. Always install ice and water shield on roofs with continuous sheathing where you know there's a history of ice damming. Some manufacturers recommend breathable underlayment, particularly in humid climates. To provide the best protection, follow the manufacturer's recommendations for coverage and overlaps.

Figure 237—The builders placed a cant strip under the shingles that bend up the side of the cupola on this cabin in Grand Teton National Park in Wyoming.

Generally, replicating the original construction is the best practice, but you must sometimes upgrade to protect the cabin. Because underlayment isn't visible after you apply the roofing, it is one area where you often can use modern materials. Upgrading to ice and water shield can prevent leaks caused by ice damming and provide extra insurance against leaks in screw-down metal roofs. It also can provide a barrier that prevents bats from colonizing attics and depositing guano (figure 238). If a Federal or State government agency owns the cabin, or if Federal or State sources provide some or all of the funding for the cabin preservation work, check with your heritage resource specialist or archaeologist to determine if you must consult with or seek approval from the SHPO for the change.

For ice-dam protection, ensure that the ice and water shield extends from the eave edge completely across the overhang and at least 2 feet up the roof from the outside edge of the cabin walls. Also, apply ice and water shield at all valleys, extending the full length of the valley for about 2 feet from each side of the valley bottom.

Some metal roofing manufacturers recommend installing a synthetic underlayment before installing any metal components. Sometimes, the building code requires additional layers of underlayment on certain parts of the roof. In some cases when water and ice shield or synthetic underlayment cover the entire roof, you don't need to apply asphalt roofing felt underlayment to the roof. Following the manufacturer's instructions, especially with metal roofing, is extremely important. Consult an engineer with experience in designing roofs to ensure that the underlayment won't create condensation or other problems for the cabin, and to also ensure that you receive the right solution to the problem you are trying to solve. For a leak-free roof, read and carefully follow the manufacturer's directions and the engineer's design.

Most roofing extends beyond the edges of the roof sheathing to allow water to drain off the roofing without soaking the sheathing and fascia (if any). Many 20th-century cabin roofs also had drip edging to help protect the sheathing and fascia. Companies manufactured historic drip edging using galvanized steel. When you're replacing historic drip edging,

Figure 238—Preservation crewmembers covered the entire roof surface of the Office/Cookhouse building at the Moose Creek Wilderness Station (Nez Perce National Forest, Northern Region) with ice and water shield before reshingling it. The crew completed the reroofing between September and May while the maternal colony of more than 500 Yuma Myotis bats that inhabited the cabin's attic was at its winter location in another part of the State. The ice and water shield not only protects the cabin from roof leaks, it also keeps the bats out. Bat guano presented a significant hazard in the attic for many years. The district provided a large bat box nearby for the colony's use.

do not use the standard preformed white drip edging commonly available today. Replace the drip edging in kind, but be sure to use at least 20-ounce (copper) or 26 gauge (galvanized steel) flashing for durability. Lighter flashing may deteriorate faster than the shingles. If you use drip edging, install the eave drip edging before the underlayment, but install the gable (sloping edge of the roof) drip edging after placing the underlayment.

If you need to install asphalt roofing felt underlayment, do so after cant strips, water and ice shield, and eave drip edging are in place. Follow the accepted practice of laying 15- or 30-pound roofing felt over the entire roof. Apply the roofing felt in rows, starting at the eaves and lapping each row at least 4 inches over the row below it. Attach the underlayment using roofing nails or staples no more than 6 inches apart in a line about 1 inch below the top of each row.

If the builders used skip sheathing on your cabin, they may have interwoven roofing felt with each layer of wood shakes, as explained in the Reroofing Using Wood Shakes section of this guide. It may be appropriate for you to duplicate this historic technique using shakes, but do not use the interwoven roofing felt technique with shingles or if the building has continuous sheathing; the interwoven felt will trap water against the wood and lead to moisture damage.

Some shingle or shake roofs have raker shingles along the gable edges and along dormer walls. Raker shingles raise the finished roof elevation enough to guide water back over the main part of the roof instead of allowing it to run off the gable edge or down the joint where the dormer wall meets the roof. Lay raker shingles perpendicular to normal shingles, with the butts along the gable edge (figure 239) or adjacent to the dormer wall. Lay the raker shingles on top of the roofing felt or ice and water shield (if any) before installing the rest of the roofing. As you install each course of roofing, overlay the raker shingles with the finish roofing.

Figure 239—The roofer at the top of the photo is laying raker shingles. The other roofer is laying the starter course. Before laying any shingles, the crew covered the entire roof with ice and water shield underlayment.

Flashing

If you replace roofing on a building that has a flue, chimney, vent pipe, dormer, or valley, you probably will need to add or replace flashing during the reroofing process. Flashing protects the building against leaks around roof penetrations, at the joints between different materials, or where different slopes meet.

The most important thing to consider when installing flashing is the path that water will take as it runs down the roof. Remember that water flows into any nooks and crannies and that sealant materials eventually fail, but overlaps last nearly forever. Likewise, the amount of overlap is important because wind can drive rain uphill into small gaps.

Use many overlapping pieces to construct flashing that protects gaps around large roof penetrations, such as chimneys and the joints between dormer walls and roofs. You must use many pieces of the flashing because materials such as brick, metal, and wood expand and contract at different rates when the temperature changes and because wind or snow loads tend to move different parts of any structure somewhat independently. The multiple flashing pieces slide past each other ever so slightly to accommodate the different movements without opening gaps that would allow water to penetrate. If you use shortcuts instead of installing flashing properly, you will pay the price in leaks.

Flashing can be made of sheet lead (figure 240), galvanized or Galvalume steel (figure 241), copper, lead-coated copper, or aluminum. Aluminum is a modern material that usually is inappropriate for use on historic cabins. In most cases, use the same material as the original flashing.

Sheet lead used for flashing is approximately $^{1}/_{16}$- to $^{1}/_{8}$-inch thick. It is easy to shape into odd angles or curves because it is such a soft metal. Unfortunately, you can absorb lead through your skin and it can cause serious health problems. Information about working safely with lead is available in the Forest Service Facilities Toolbox section on lead roofing and flashing <http://www.fs.fed.us/eng/toolbox/haz/haz22.htm>. Always use these safe-handling methods when you work with lead and lead-coated copper.

Figure 240—The lead on the left is lead wool. You can use it to pack the joints behind the mortar in a chimney and hold the flashing in place. The lead on the right is used lead sheet flashing.

When purchasing copper or lead-coated copper flashing, buy 20-gauge for a good balance of strength, durability, and workability. For galvanized steel, 32-gauge is typical for sheet or rolled flashing material and 26- or 28-gauge is typical for preformed shapes. Steel and copper are both more rigid than lead, but copper is easier to form than steel. Lead-coated copper is stiffer than lead sheet, but easier to shape than plain copper because the lead coating acts as a lubricant. Steel is quite rigid and you generally can only use it in flat or folded sheets. Unlike lead and copper, steel flashing may corrode when it contacts mortar, copper, lead, uncured wood, or pressure-treated lumber. On the other hand, copper may corrode when in contact with wet cedar shingles or shakes. Lead-coated copper combines copper's durability with lead's acid rain resistance and nonstaining properties.

Figure 241—This roofer is installing galvanized steel step flashing and valley flashing during the reroofing of this complex roof at the historic Ninemile Ranger Station (Lolo National Forest, Northern Region).

Install flashing using nails of the same or compatible material to prevent galvanic corrosion. Do not use aluminum and steel, aluminum and copper, or copper and steel together. Stainless steel isn't compatible with either galvanized or zinc-coated steel, so do not mix them. You can use hot-dipped galvanized, copper, or stainless steel fasteners with lead flashing. When installing flashing, use short nails with a broad head that will hold the flashing in place without going completely through the sheathing.

Chimney Flashing

The first step for flashing a brick, stone, or cement block chimney is to rake out all of the brick joints immediately above an imaginary line 5 inches above the roof line (figure 242). Raking out the joints means removing the mortar to about a ¾-inch depth from the face of the bricks. Use a hammer and stone chisel, rock hammer, double jack, or similar tools (figure 243). Be very careful. If you break any of the masonry, you will have to rebuild the chimney. Consider also making any other needed repairs to the chimney while you're at it. See the Fireplaces, Wood Stoves, Chimneys, and Flues section of this guide.

Figure 242—In preparation for reflashing, a preservation crewmember raked out the mortar from the joints on the chimney of the house at the Main Boulder Station (Gallatin National Forest, Northern Region) built in 1905.

Chimneys that extend through shake or shingle roofs need four types of flashing (figures 244 and 245): base (sometimes called apron flashing), step, counter (sometimes called cap flashing, figure 246), and saddle (sometimes called cricket flashing). You can shorten the chimney-flashing task by measuring the chimney and cutting all the pieces of flashing before beginning installation.

Figure 243—This preservation crewmember is using a hammer and plugging chisel to rake the joints on the chimney of a house built in 1905 at the Main Boulder Station (Gallatin National Forest, Northern Region).

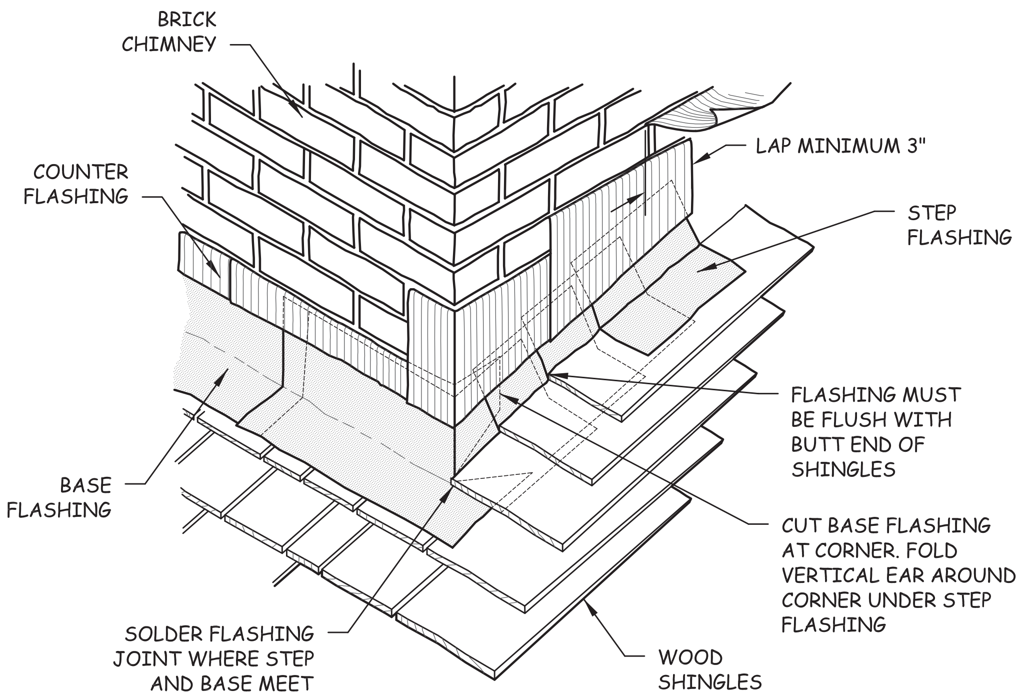


Figure 244—This drawing shows the base flashing, step flashing, and counter flashing around the lower corner of a masonry chimney. Use the same flashing methods at the lower corners of dormers.

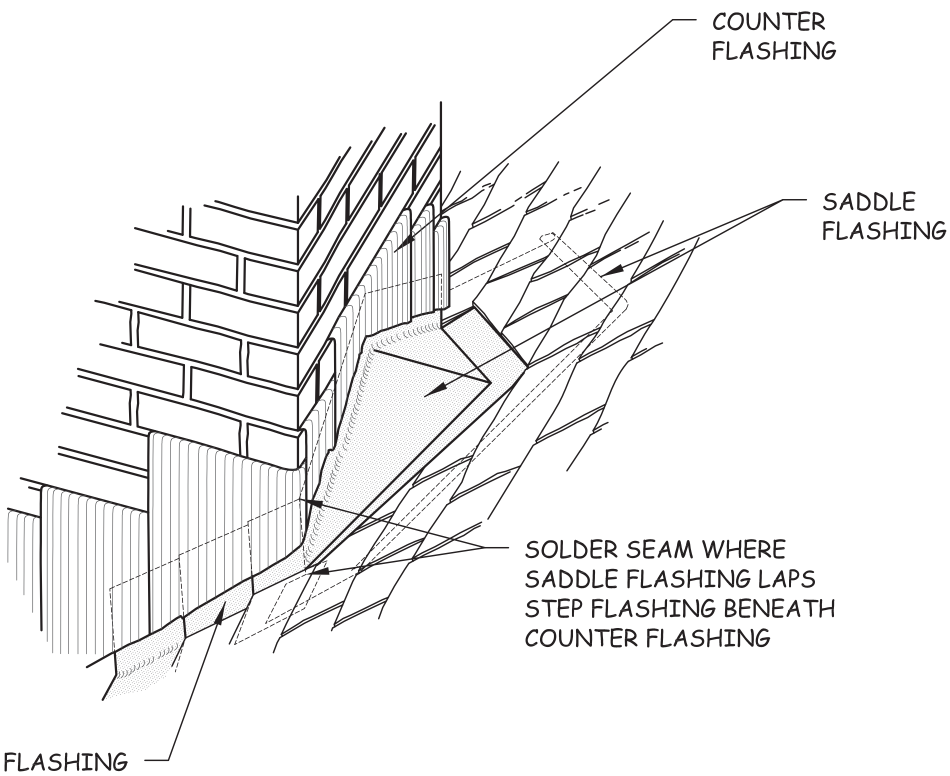


Figure 245—This drawing shows the saddle flashing, step flashing, and counter flashing at the upper side of a masonry chimney.

Figure 246—This closeup view of the chimney constructed in 1905 at the Zortman Guard Station within the Bureau of Land Management's HiLine District in Montana shows how the builder used lead sheets to counter flash the chimney. The builder stuffed lead wool into the masonry joints to match the original method of holding the counter flashing in place. The step flashing under the counter flashing is just barely visible.

To flash the chimney, first, cut the roofing below the chimney flush against the base of the chimney. Then, place base flashing across the width of the downhill side of the chimney. Extend it a short distance up the chimney and down over the top of the roofing that you cut to butt into the chimney. Fold it around the bottom corners of the chimney and tuck it up along the sides.

Next, with each course of roofing, lay step flashing up along the sides of the chimney. Lay the lowest course of step flashing over the base flashing at the lower side of the chimney. When laying the roofing courses with the step flashing, don't nail closer than 3 inches from the chimney. If you're roofing with wood shingles or shakes, you may end up with nails in the middle—instead of within 1 inch—of the edge of the shingles or shakes in your efforts to keep nails away from the chimney. This deviation is acceptable when you're nailing into flashing.

When your roofing course work reaches the upper side of the chimney, lay saddle flashing across the uphill side of the chimney so that it extends up the chimney and overlays the step flashing at the sides. Form saddle flashing into a peak at the middle to encourage drainage. Cut the roofing in the courses crossing the saddle flashing to fit, as shown in figure 245.

If the uphill side of the chimney has a framed cricket, you don't need saddle flashing. If necessary, rebuild the cricket to match the historic shape. Flash the joint between the chimney and the roofing on the cricket using step and counter flashing, just like on the sides of the chimney. Flash the valley between the main roof and cricket, as explained in the Valley Flashing section of this guide.

Finally, place counter flashing (figure 247) in the mortar joints and fold it down to overlay the apron, step, and saddle flashing. To keep galvanized steel or copper counter flashing in the raked mortar joint while you work, crimp the end of the horizontal leg of the flashing into a "C" shape the same size as the mortar joint or use lead wool or mortar to keep L-shaped flashing in place. Lead flashing is flexible enough that L-shaped flashing will stay in the joint if you press it tightly to the masonry. Solder all the corners, being careful to seal the pinhole opening at each corner where the base or saddle, step, and counter flashing all come together. Be careful while soldering—you don't want solder dripping onto the shingles, nor do you want to start a fire.

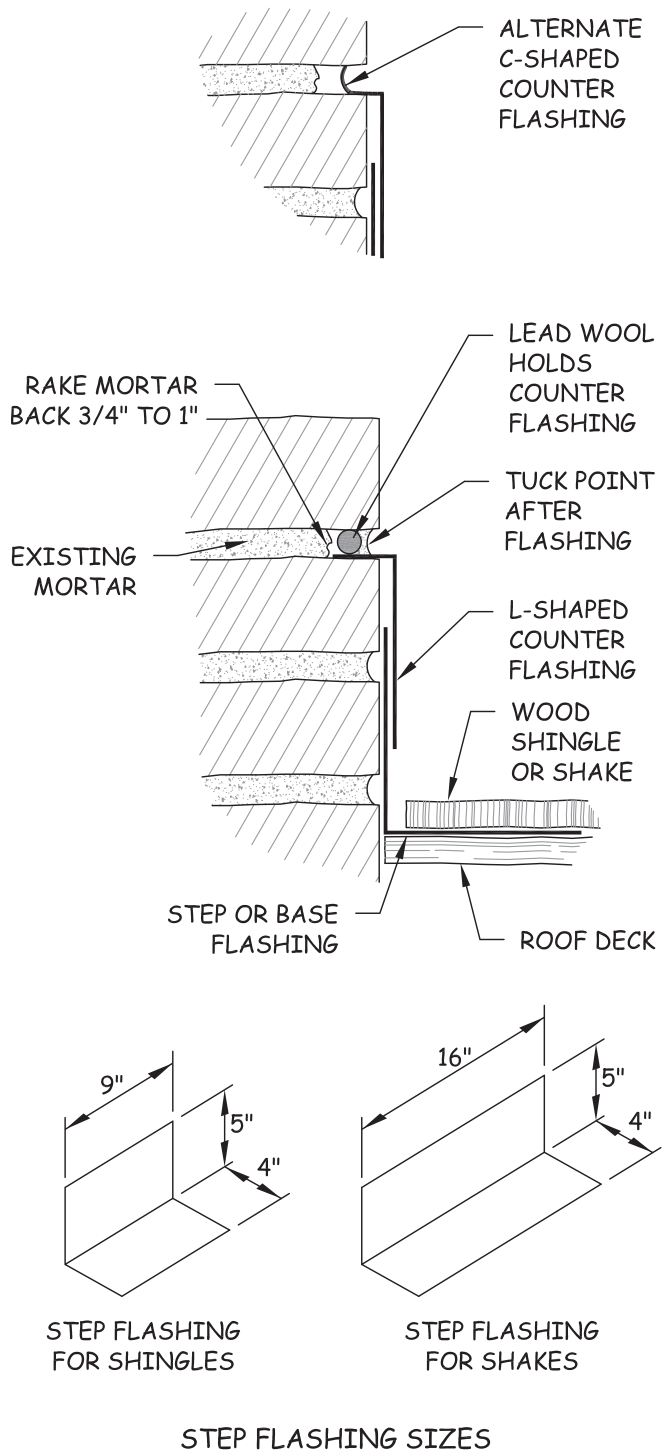


Figure 247—This detail drawing shows how to size and install step flashing and counter flashing on a masonry chimney.

After you place all the counter flashing, repoint the joints that you raked out. If the builders originally filled the joints with mortar, match the original color and type of mortar using the same method used for matching masonry daubing explained in the Chinking and Daubing section of this guide. If the builders originally packed the joints with lead wool, repack them with matching lead wool. Remember to pack the wool in tightly to keep out water.

When you finish installing the flashing, the metal will surround the chimney (figure 248). The flashing will guide water away from the chimney and onto the surface of the roof so that water, snow, and ice won't penetrate the roof.

Construct chimney flashing for a metal, rolled asphalt, or sod roof in a similar fashion. However, instead of step flashing, use one long piece of flashing that runs up the slope of the roof for the entire length of the side of the chimney. Counter flash in the same manner as you would with shingles or shakes—in steps running up the courses of masonry to approximately match the angle of the roof.

Vent Flashing

Buying a premade combination vent boot or vent sleeve and flashing unit to slide over each vent stack and flue is much easier than hand-shaping and soldering a separate boot or sleeve and flashing sheet. Premade vent flashing is great for newly installed vents or to replace older premade flashing, but is not appropriate for replacing historic, individually crafted boots and flashing. If you use a premade flashing unit, install it so that the flat sheet runs over the lower course of roofing and under the upper and side courses. Be sure to buy a unit with a large flashing sheet so that the flashing extends beyond the vent boot at least 4 inches on all sides.

Figures 249 and 250 show historic flashing methods for vents. The advantage of the historic sleeve and flashing method shown in figure 249 is that it doesn't require sealant or exposed fasteners, and the pipe and cap can move separately from the roof and flashing. Leaks commonly develop over time at sealant joints and fastener penetrations, so the older, more difficult methods tend to be more durable. Figures 249 and 250 also show how the flashing sheet extends under the top and side shingles but lies over the shingles below the vent, which is the same way you should install modern, premade combination units. The folds in the flashing guide any water that penetrates the overlapping shingles down the flashing and out onto the roof surface so that the roof sheathing doesn't get wet.

Figure 248—Preservation crewmembers replaced the flashing all around the chimney at the Lost Horse cabin (Bitterroot National Forest, Northern Region).

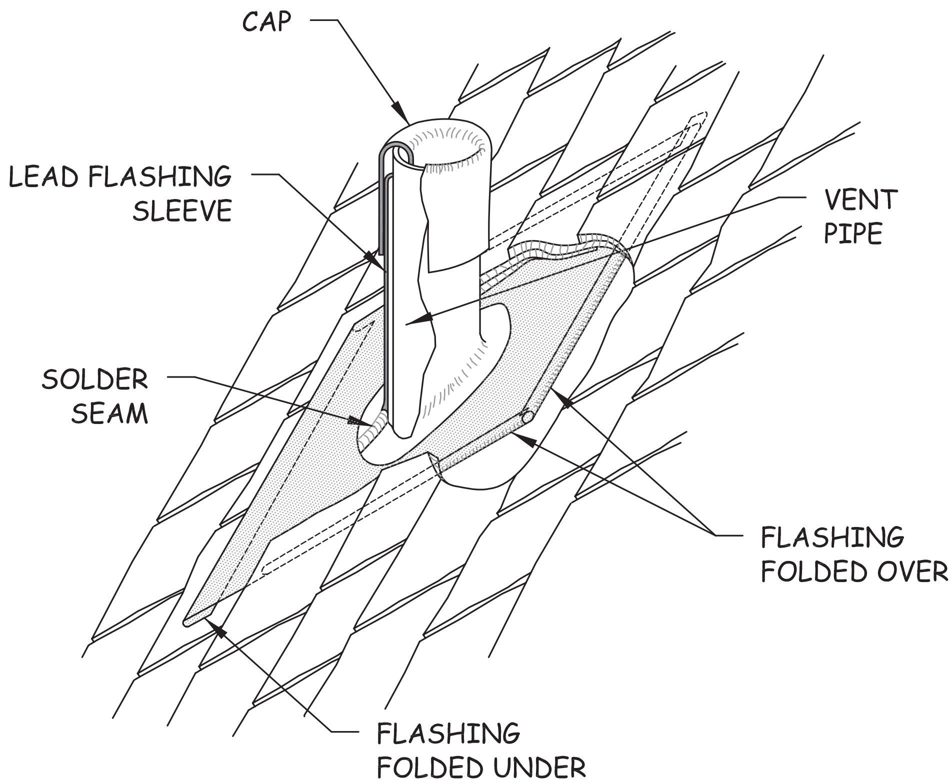


Figure 249—This drawing shows a historic method for using lead flashing, a sleeve, and a cap around a roof vent.

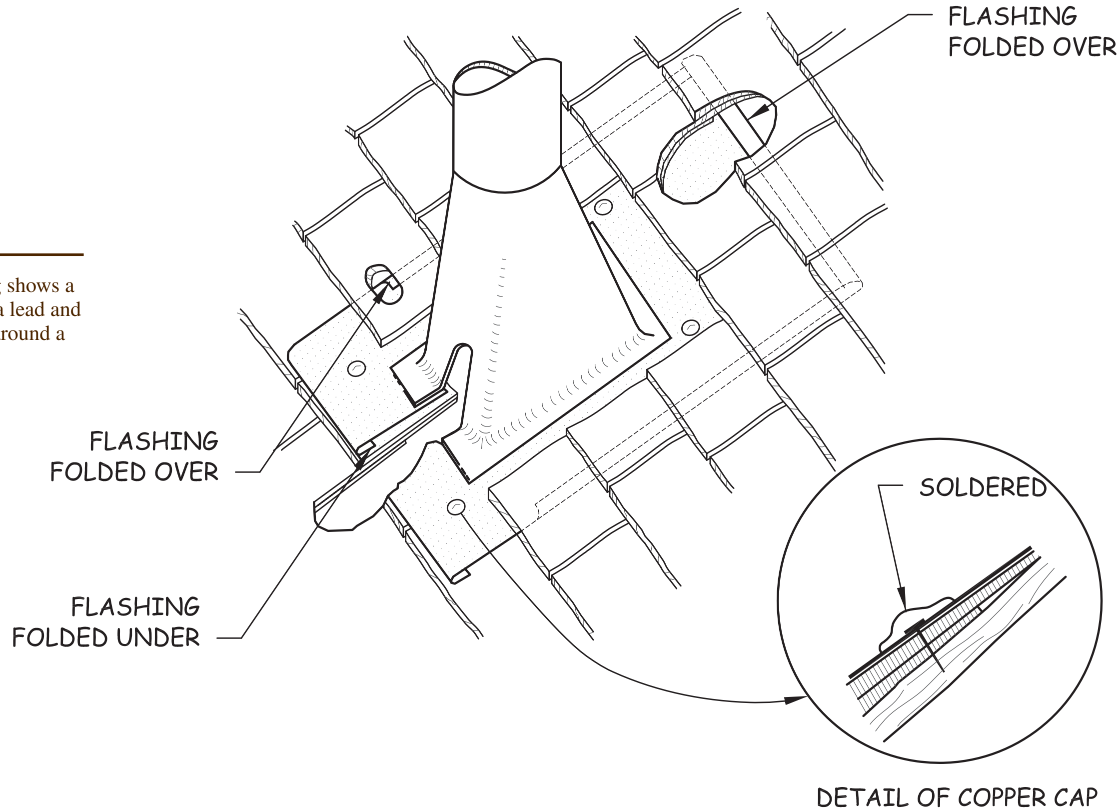


Figure 250—This drawing shows a historic method for using a lead and copper boot and flashing around a roof vent.

Cut shingles around larger vents and flues to fit around the boot (figure 251). You won't need to trim many shingles as you lay them around smaller vent pipe sleeves (figure 252).

Figure 251—A preservation crewmember trimmed the shingles around this booted flue on the Moose Creek Wash House (Nez Perce National Forest, Northern Region).

Figure 252—The shakes around this small vent in the Moose Creek Ranger's House (Nez Perce National Forest, Northern Region) required little trimming.

Valley Flashing

Install valley flashing after installing the asphalt felt roofing paper and before installing the roofing. On buildings with continuous sheathing, consider carefully installing a continuous layer of ice and water shield along the full length of the valley before laying the asphalt roofing paper. This provides an extra measure of leak protection. Before laying the flashing, extend felt asphalt roofing paper from each side completely across and at least a foot beyond the center of the valley (figure 253).

You can make valley flashing from flat metal sheets or rolls. You also can buy it preformed in a "V" shape (figure 254) or a "W" shape (figure 255) with or without hems (metal folded back on itself) or crimps at the edges. The ridge in the middle of W-shaped valleys is called a splash rib. You can find metal flashing at most building supply stores in 10- or 20-foot lengths and either 16- or 24-inch widths, which means it will extend 8 to 12 inches beyond the centerline of the valley.

Valley flashing is easy to install, as long as you make sure to align the middle of the flashing along the low point of the roof valley. Just lay the flashing in place and nail it down along the edges. Begin laying valley flashing at the roof eave and work up the roof. If the valley requires more than one length of flashing, overlap each section by at least 4 inches. Then, install the roofing shingles, lapping the shingles at least 6 inches over the flashing and trimming the shingles to match the angle of the valley (see figure 254).

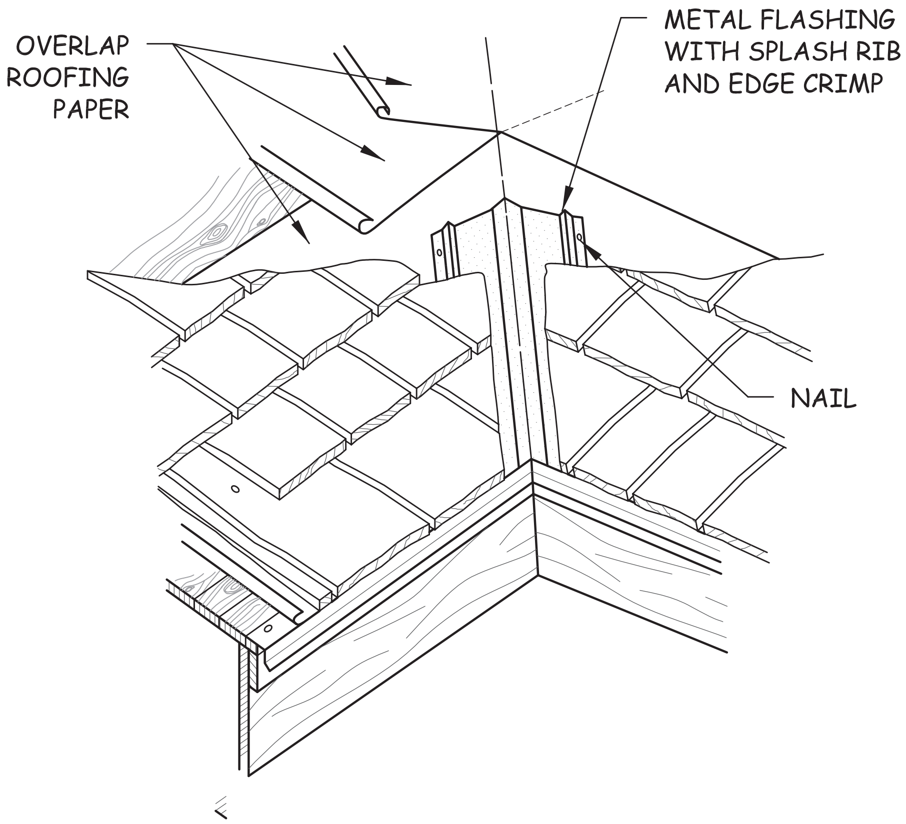


Figure 253—This drawing shows how to place roofing paper, valley flashing, and shingles over continuous sheathing. If you use ice and water shield, install it under the roofing paper directly onto the sheathing.

Figure 254—Preservation crewmembers used V-shaped valley flashing while replacing the roof at the Phillipsburg Ranger Station (Beaverhead-Deerlodge National Forest, Northern Region). Note how the crew cut the shingles that overlap the flashing on a diagonal to match the chalkline.

Figure 255— Preservation crewmembers used W-shaped valley flashing when they replaced the roof on this building at the Ninemile Ranger Station (Lolo National Forest, Northern Region).

Roof valleys on cabins in locations that frequently receive heavy rainstorms often have a tapered run that is wider at the bottom than at the top to accommodate the larger flow of water that accumulates near the bottom of the valley. To lay out a typical tapered run, install the valley flashing as usual, using 24-inch-wide flashing. Measure and mark 3 inches from each side of the center at the top of the valley. Next, measure and mark 4 inches from each side of the center at the bottom of the valley. Then, snap a chalkline from the marks at the top of the valley to the marks at the bottom. This gives you a tapered line. Lay the roofing as you normally would and trim the roof material to match the chalkline.

Rolled asphalt roofing valley flashing and woven asphalt shingle valleys tend to not be as durable as metal valleys. Over time, asphalt roofing tends to pull away from the roof sheathing and to crack where it bends, especially in climates with hot summers and cold winters. Don't give in to the temptation to shortcut your roofing project by using either of these two methods, unless you must do so to retain the historic character of the building. If you must use one of these methods, lay ice and water shield the full length of the valley before placing the asphalt felt roofing paper and roofing.

The best valleys have 4 to 8 inches of exposed metal in the middle (called an "open valley"), a central splash rib, and either a hem or a crimp near each side edge. You may need to install a different valley flashing from the one the cabin originally had. The SHPO probably will need to review or approve noticeable changes in appearance if a Federal or State government agency owns the cabin, or if Federal or State sources provided some or all of the funding for the cabin preservation work. Check with your heritage resource specialist or archaeologist for the requirements.

Dormer Flashing

Install dormer flashing (figure 256, and also see figure 228) on the lower edge and sides of the dormer in much the same way you install chimney flashing. Where the roof of peaked dormers meets the main roof, install valley flashing as explained previously. Handle flashing at the top of shed roof dormers the same way you would handle any other roof pitch transition. Generally, use base and step flashing on the lower edge and sides of a dormer, exactly as you would a chimney. If the dormer is sided with shingles, shakes, or siding boards, install the upper portion of each piece of step flashing under the siding and don't use counter flashing; the siding functions as counter flashing. Where the valley flashing for a peaked dormer meets on the ridge, fold the two pieces together and solder them along the joint.

Roof Pitch Transition Flashing

Where a porch or shed dormer roof with a shallow slope meets a steeper slope on the main roof (see figure 228), or where the pitches meet on a gambrel roof, you probably need to install flashing to help deflect water. In these cases, install the flashing after you lay the roofing on the lower section but before you lay the roofing on the upper section. Lay the flashing over the roofing on the lower section of roof. Lay the flashing over the asphalt felt roofing paper but under the roofing of the upper section.

Builders also frequently use flashing under the ridge shingles of a Boston ridge on wood shake and shingle roofs. See the Ridge Caps for Wood Shake and Shingle Roofs section of this guide to learn this method.

Figure 256—The shed roof dormer on the back of the Big Prairie Ranger Station (Flathead National Forest, Northern Region) has flashing at the base, sides, and top. The roofers installed base flashing where the lower side of the dormer meets the roof. The board and batten siding on the sides of the dormer covers most of the step flashing. The roofers also installed flashing at the transition between the top of the dormer roof and the main roof (not visible in the photo).

Roofing Fasteners and Tools

We all love labor-saving building tools, but using a shingle hatchet (figures 257 and 258) or a lightweight smooth-faced hammer to drive nails flush with the shingle or shake surface still is the best way to attach wood or asphalt shingles to historic roofs. Do not use a wafflehead hammer for roofing on a historic building; it will leave a waffle mark around the nail heads. The marks are unsightly, don't conform to the historic appearance of the building, and hold water, leading to rot.

Do not use nail guns to attach roofing. The common practice of using pneumatic nail guns can crack the roofing or shoot fasteners completely through it, leading to its premature failure. Using nail guns is the normal roofing practice these days, but the author has spent too much time repairing relatively new roofs that someone nailed using a nail gun to recommend this practice under any circumstances. If you plan to contract out the roofing work, contact the Northern Region Historic Preservation Team at <http://fsweb.r1.fs.fed.us/e/FacilitiesAndEnvironmental/HistoricPreservation/include_home.htm#team> or 406–329–3478 for copies of shingle roofing specifications that have successfully required roofers to use hand nailing techniques.

Use caution when you install metal roofing using power screwdrivers. Overdriving screws results in gasket or clip damage and a leaky roof. Underdriving screws leaves tiny gaps through which water can penetrate. Figure 259 shows the difference between properly driven, underdriven, and overdriven gasketed screws. If you use power screwdrivers, check and adjust the torque settings several times during the day as the temperature changes.

Figure 257—This older shingling hatchet serves the same function as newer models—use the hammer end to drive nails, the hatchet end to trim shingles, and the notch in the hatchet to pry out nails.

Figure 258—These newer shingling hatchets work exactly the same way as the older hatchet shown in figure 257. Their steel handles are less likely to break, but the basic design hasn't changed much in more than 100 years.

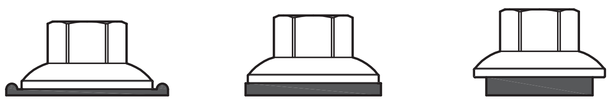


Figure 259—The drawing on the left shows an overdriven roofing screw with a deformed gasket. The drawing in the center shows a roofing screw that is driven correctly, with the gasket just barely visible around the edges of the flange. The drawing on the right shows an underdriven roofing screw. The gasket is not visible around the edge of the flange and is not compressed enough for the gasket to seal properly.

Use the correct type of fastener. Do not use staples to attach shingles or rolled roofing. Staples are more likely than nails to cause rips or cracks in the roofing, even if you set them perfectly. Instead, use box nails (for wood shingles or shakes) or broad head roofing nails (for asphalt rolls or shingles) with shanks long enough to extend through the roofing and about three-fourths of the roof sheathing. For shingles and shakes, use corrosion-resistant roofing nails (stainless steel type 304 or 316, hot-dipped zinc coated, or aluminum). Do not use copper nails with cedar roofing because a chemical reaction between the wood and the copper will corrode the nails and reduce the life of the roof. Do not use nails that penetrate the sheathing; they will provide a pathway for leaks.

For metal roofs, follow the manufacturer's recommendations for fasteners. If the manufacturer has not provided recommendations, use self-tapping metal-to-wood roofing screws with gasketed flanges. Builders historically attached metal roofs using lead-headed nails, but nails are far more prone to leaking and popping than gasketed roofing screws; they no longer are recommended for use.

Roofing professionals disagree on the best location to place fasteners to attach corrugated and ribbed metal roofs. Manufacturer's instructions usually say to drive screws in the valleys of corrugated roofing and on the flats of ribbed roofing. Because neoprene gaskets don't last as long as the metal of the roof and water is more likely to leak around a wornout gasket in the valley than in the peak, many long-time roofers suggest fastening through predrilled holes in the tops of the ribs or peaks of corrugations. The author doesn't recommend this practice because you easily can damage ribs and unsupported corrugation peaks while fastening them. Replacing wornout gaskets simply is part of normal maintenance for metal roofing. If you disregard the author's advice and decide to fasten through the tops of ribs or peaks of corrugations, remember that you must use longer screws. Use screws that are long enough to extend at least halfway and no more than three-fourths of the way into the sheathing. You can buy roofing screws for metal panels in carbon steel, stainless steel, and with a salt spray coating. Buy screws that provide the longest service for your climate and the type of panel you use.

Reroofing With Wood Shingles

For shingles, "exposure" refers to the surface of the shingle that is exposed to the weather and not covered by the shingle above it. Usually, roofers lay 16-inch wood shingles with a 5-inch exposure, 18-inch shingles with a 5½-inch exposure, and 24-inch shingles with a 7½-inch exposure. This provides a triple layer of protection to the entire roof (figure 260).

If the builders laid historic shingles differently but still provided a triple layer of protection—such as with a 4½-inch exposure—use the historic pattern. If the historic shingles don't provide a triple layer of protection, consider changing from the historic shingling pattern to a pattern that provides proper overlap. This will make the roof last longer. Because this pattern changes the appearance of the roof, if a Federal or State government agency owns the cabin, or if Federal or State sources provide some or all of the funding for the cabin preservation work, check with your heritage resource specialist or archaeologist to determine if you must consult with or seek approval from the SHPO for the change.

Lay wood shingles with a ¼- to ⅜-inch gap between horizontally adjacent shingles. This gap is called a joint. Each horizontal row of shingles is called a course. Stagger the joints for each successive course at least 1½ inches horizontally from the joints in the course immediately below and 1½ inches from the joints in the second course below so that precipitation cannot flow through stacked joints and soak the sheathing or leak into the building. You must stagger joints for the triple layer of protection (figure 261) to work properly and to provide a leak-free wood shingle roof.

When laying shingles, ensure that each shingle or shake covers the nails from the course below. Use two nails per shingle and set the nails between 1¼ and 2 inches above the exposure line and ¾ to 1 inch in from the edges (figure 262). Exposed nail heads, called shiners, not only are unsightly, they also provide a water path to the sheathing and building interior. Nails set too high on the shingle are likely to split the shingle over time, leading to leaks.

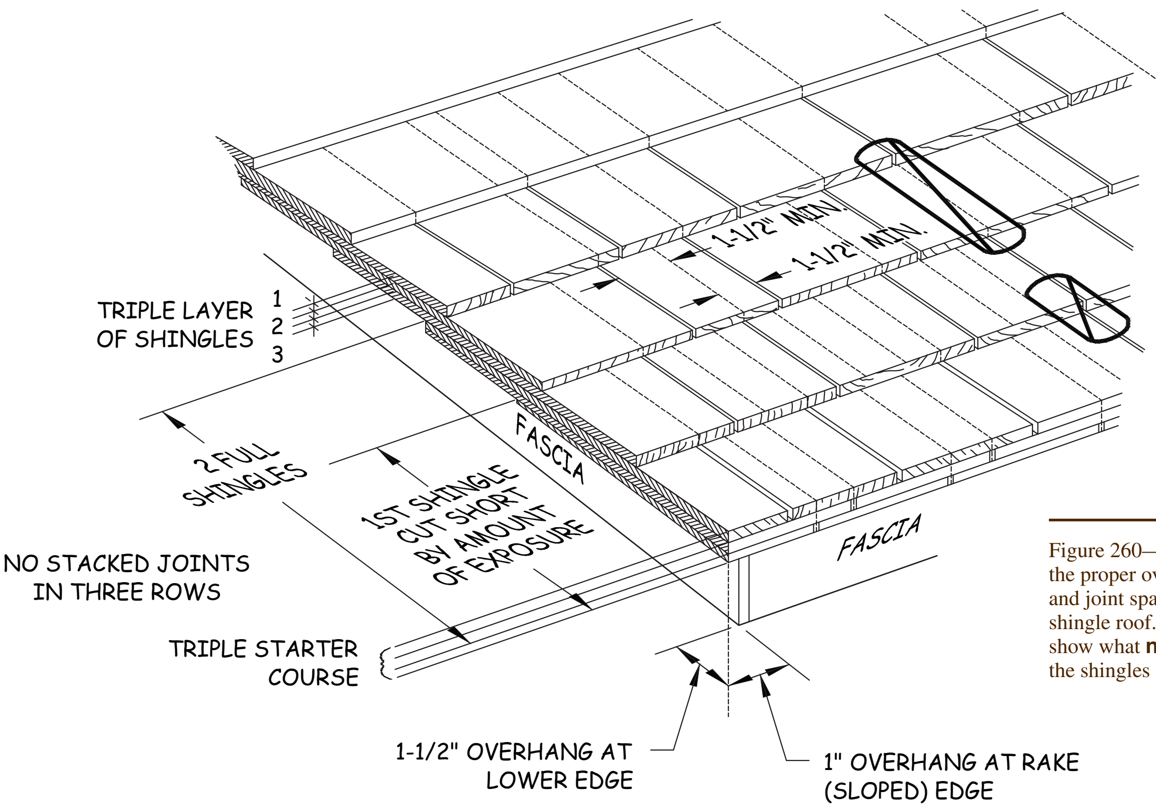


Figure 260—This drawing shows the proper overlaps, overhangs, and joint spacing for a wood shingle roof. The "⃠" symbols show what **not** to do: don't lay the shingles with stacked joints.

Figure 261—This edge view of the stud barn roof at the Nine Mile Ranger Station (Lolo National Forest, Northern Region) shows rakers and three layers of shingles. The shingles immediately above the fascia are rakers. You can tell which shingles are rakers because their end grain is exposed, rather than the edge grain exposed on the sides of other shingles.

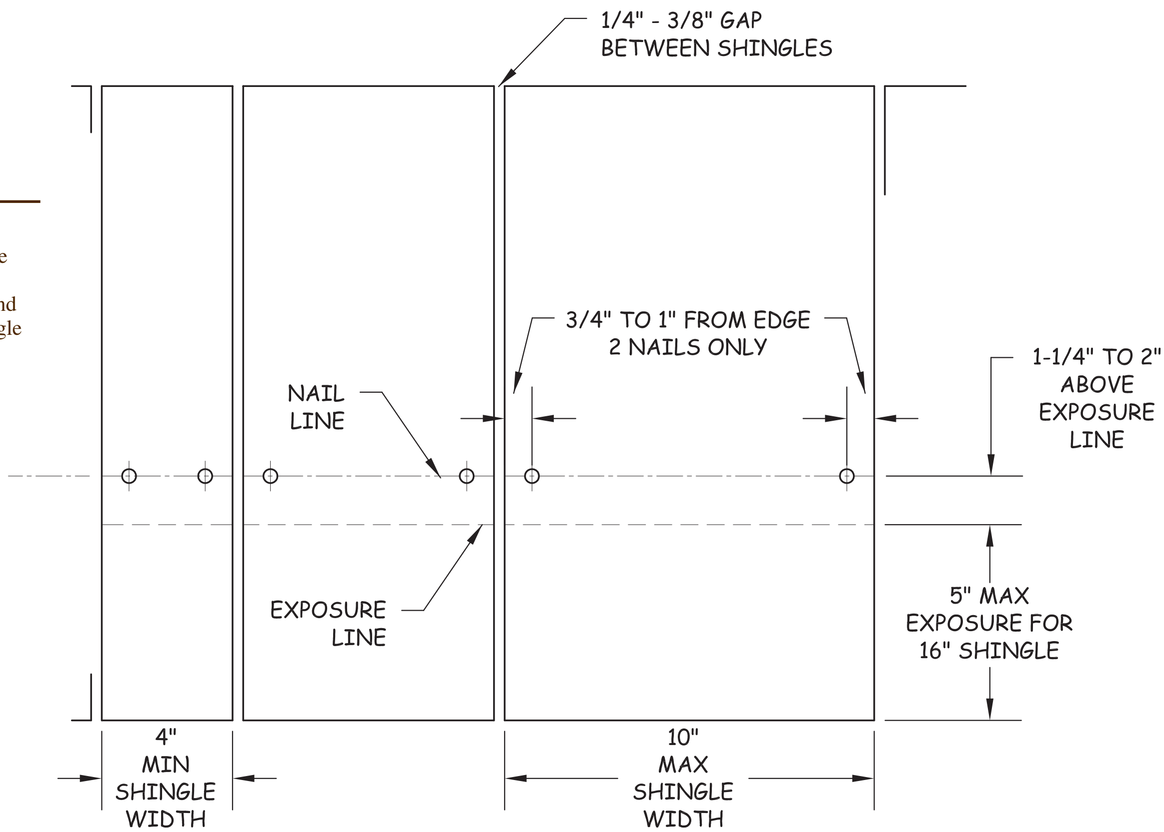


Figure 262—This drawing shows the proper exposure, nailing patterns and spacing, and shingle width for a wood shingle roof.

Only use shingles that are between 4 and 10 inches wide. Split wider shingles into narrower shingles. Discard any shingles narrower than 4 inches or use them elsewhere as shims or for kindling. Hand drive the nails and set them flush with the surface of the shingle. Do not drive the nails below the surface of the shingle; the wood fibers will break, causing early deterioration and rot. Do not overdrive the nails to achieve the required penetration of one-half to three-fourths of the sheathing depth; buy longer nails.

Generally, lay the shingles so that the starter courses project 1½ inches beyond the eave or fascia and lay the gable edge shingles so that they extend 1 inch beyond the gable fascia or sheathing. If the builders laid the historic shingles so that they projected out farther, lay the new shingles the same way.

To easily get an even spacing for the 1-inch overhang on the gable ends, snap a chalkline from the peak to the eave, 4 inches in from the rake edge. When you pick the shingles for the gable ends, choose shingles that are more than 5 inches wide and make a pencil mark 5 inches from the outside edge of each gable end shingle. Line up the mark with the chalkline for a perfect 1-inch overhang (figure 263). If you must use a shingle narrower than 5 inches, use a tape measure to position the shingle.

Lay shingles with a triple starter course. Unless the sheathing is uncommonly thick, the nails for the first layer will go through the sheathing because box nails less than 1¼-inches long aren't commercially available. This protrusion won't lead to leaks inside the building because of the coverage from the second and third layers of the starter course, so don't worry about it.

The first starter course layer is the shortest. To easily cut shingles to the correct length for the first starter course, lay the shingles so that the butts extend over the eave line by a distance that is equal to the length of the normal shingle exposure plus 1½ inches. Snap a blue chalkline 1½ inches beyond the eave or fascia and cut the shingles off at the line using a small circular saw (if you have one), or a hand saw. Trimming the first layer is extra work, but it provides a triple starter course without the pagoda look. Use the same technique at the pitch transition on gambrel roofs (figures 264 and 265).

Figure 263—You can use a chalkline to produce even spacing for rake edge overhangs on both shingle and shake roofs. Roofers are installing this shake roof on the Office/Cookhouse building at the Moose Creek Wilderness Station (Nez Perce National Forest, Northern Region).

Figure 264—This roofer is using a small circular saw to cut off the first course of shingles on the gambrel of the stud barn at the Nine Mile Ranger Station (Lolo National Forest, Northern Region).

Figure 265—The overhang at the gambrel pitch change on the stud barn at the Ninemile Ranger Station (Lolo National Forest, Northern Region) creates the deep shadow line visible in the middle of this photo.

Next, lay the second starter course of shingles, aligning the butts with the butts of the shorter first starter course shingles. After you place the second starter course layer, you may find it helpful to mark the asphalt felt roofing paper or the shingles with pencil lines that indicate the location of the vertical joints of the starter course layers. Marking the joints allows you to easily space subsequent layers to avoid stacking the joints without bending over to look at the edge of the eave. Lay the third starter course directly on top of the two previous courses.

After you finish the triple starter course but before you start to nail succeeding courses, measure from the eave to the peak on both sides of the roof. If the roof isn't square, slightly adjust the exposure measurement on one side of the roof for several courses until the measurements come out even. Do not adjust more than ½ inch on any course, or the adjustment will be visible from the ground.

Although it takes more time, measure up from the eave—not from the course below—to mark the stringline for each successive course of shingles. Each course will be evenly spaced if you measure from the eave, because you're measuring from the same point. To mark the bottom edge of each shingle course, stretch a chalkline all the way across the roof, from side to side between measured marks, and snap it. Lay the shingles along that line (figure 266). You also can snap a second chalkline to guide nail placement 1¼ to 2 inches above the exposure line for each course, if you wish.

Pause for a reality check when you have covered the lower half of the roof with shingles. If the highest half dozen courses of shingles or shakes aren't parallel with the ridge cap, you will have an ugly roof. To check whether the courses you've laid so far are parallel with the roof ridge, measure from the course line to the ridge at each edge of the roof and in the middle. If you find that the courses aren't parallel to the ridge despite the adjustment you made after laying the triple starter course, stop measuring from the eave for each course and measure from the ridge as you shingle the rest of the roof. Adjust the course line spacing over several courses as described earlier.

Figure 266—This roofer is laying shingles in courses on the west house at the historic Ninemile Ranger Station (Lolo National Forest, Northern Region). The shingle courses are evenly spaced due to careful measuring and the use of chalklines. The chalkline for the current course is visible in the photo. The horizontal spaces between the shingles are reasonably even.

To roof across a concave roof pitch transition, such as from a porch roof to the main roof, your shingles must be flexible enough to bend a little without cracking. Soak bundles of shingles in water overnight to make them flexible. Lay the soaked shingles tight, with no more than a ⅛-inch joint between adjacent shingles. The shingles will dry out and shrink, producing normal joint spacing but retaining their slight curve. You may have to stand on the shingles as you nail them to get them to flex across the transition. Use flashing where the pitch changes sharply; shingles flex only so far, even after soaking.

Cut off the tails of the shingles in the courses near the peak of the roof to make them even with the peak. You can cut the tails on the ground before installing them or cut them after you nail them to the roof (figure 267). If you choose to cut the shingle tails after installation, lay a shingle course on one side of the roof and use a saw to cut the tails, then switch to the other side and repeat the process. Switch back to the other side and use the same process until you reach the ridge. This method of switching from one side to the other interweaves the shingles at the peak, adding extra weather protection. Do not lay a course so close to the ridge line that you have to cut the shingles shorter than the weather exposure or shorter than the width of the ridge cap. Install the ridge cap as described in the Ridge Caps for Wood Shake and Shingle Roofs section of this guide.

Figure 267—This roofer is using a small circular saw to cut the tails off shingles near the ridge of a roof.

Reroofing With Wood Shakes

Install shake roofs in much the same way as shingle roofs, but with some differences. For instance, lay double starter courses for shake roofs rather than the triple starter courses you would lay for shingle roofs.

For most roofs, lay 18-inch shakes with a 5½-inch exposure, 24-inch shakes with a 7½-inch exposure, and 36-inch shakes with an 11-inch exposure. This method provides a triple layer of protection for the entire roof. If the original builders laid the historic shakes with a different exposure that provides a triple layer of protection, install the new roofing with the same exposure.

If the historic roofing doesn't provide a triple layer of protection, consider using longer shakes or a shorter exposure length when reroofing, even if it changes the appearance of the roof. A roof that leaks hastens the deterioration of the cabin, so the longer life of the building may be well worth the change of appearance. If a Federal or State government agency owns the cabin, or if Federal or State sources provide some or all of the funding for the cabin preservation work, check with your heritage resource specialist or archaeologist to learn if you must consult with or obtain approval from the SHPO for the change.

Lay shakes with ⅜- to ⅝-inch spaces, called joints, between adjacent shakes on each horizontal course. As with shingle joints, stagger the shake joints at least 1½ inches to prevent joint stacking and leaks.

For shake roofs on solid sheathing (figure 268), handle the nailing, measuring and marking of courses, roof jacks, overhangs, pitch transitions, and shakes near the peak of the roof the same as you would with shingle roofing. Roofing methods are a little different if you lay the shakes directly on purlins or on skip sheathing.

Figure 268—Roofers are installing a new shake roof on the Wash House at the Moose Creek Wilderness Station (Nez Perce National Forest, Northern Region). This 1937 log building has solid roof sheathing.

Builders sometimes interwove 30-pound asphalt roofing felt between shakes laid on skip sheathing (figure 269). To interweave roofing felt, lay the bottom edge of each row of felt two times farther from the butt end of the shakes as the distance of the weather exposure. For example, if the shakes are 24 inches long, the weather exposure is 7½ inches, so position the bottom edge of the felt 15 inches beyond the butt end of the shake so that it covers only the upper 9 inches of the shake. The skip sheathing for the courses above supports the upper part of the felt.

If you lay shakes directly on widely spaced purlins with no sheathing, you may need to double course the shakes. Double coursing simply means that you lay two layers of shakes in each course (figure 270), with little overlap between courses. Shake exposure varies according to the length of the shakes and the spacing of the purlins. If you lay double courses, don't forget to stagger the joints on the two layers of shakes in each course and to stagger the joints from the succeeding and previous courses.

The original builders didn't always match the shake length to the purlin spacing. Even if the original builders used shakes long enough to properly span the purlin spacing, subsequent roofers replacing roofing may have used shorter shakes. Unless photographic or other evidence shows that the original shakes didn't span the purlins properly, use extra-long shakes that match the purlin spacing (figure 271) to provide a more durable, water-resistant roof. If you must use short shakes to replicate the historic appearance, set the nails into the purlins. The nails will be visible on the finished roof, but that's less important than securely attaching the shakes to the roof structure.

People who spend time in cabins with shake on purlin roofs during dry summer weather sometimes are disconcerted to discover that they can see a few stars through the roof at night or a glow of sunlight during the day. Although the stars or sunlight are visible, a sound, properly constructed shake on purlin roof won't leak, except during some wind driven rain events. The shakes are positioned to shed water. Also, when the shakes get wet, they swell and make a tighter roof.

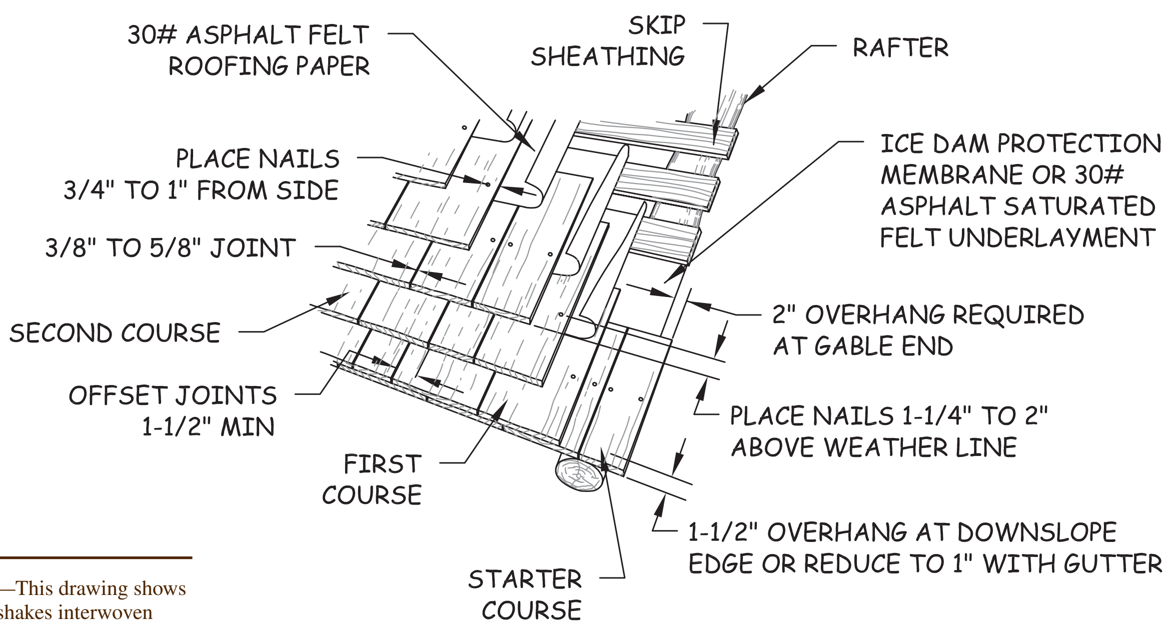


Figure 269—This drawing shows how to lay shakes interwoven with roofing felt on skip sheathing.

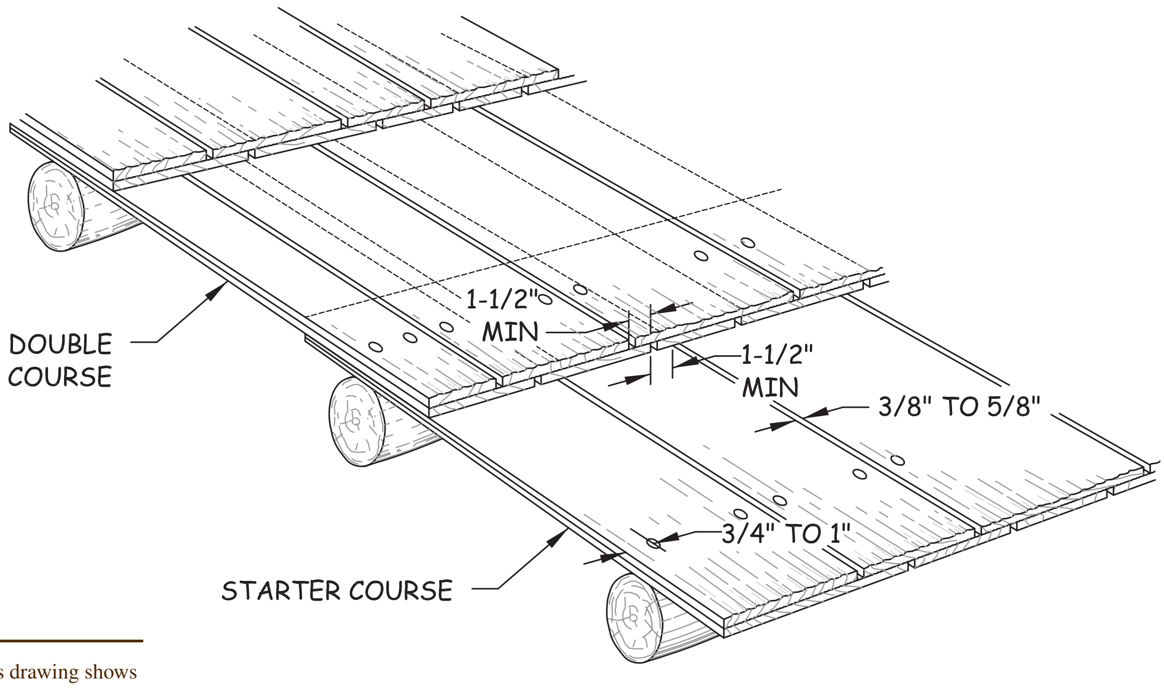


Figure 270—This drawing shows how roofers commonly lay double coursed shakes directly on purlins.

Figure 271—This crew laid 32-inch-long shakes on the purlin roof of the fire cache at the Moose Creek Wilderness Station (Nez Perce National Forest, Northern Region) during the 1990s. If they were laying the shakes today, they all would wear hard hats and would wear fall protection harnesses while working on the upper courses.

Ridge Caps for Wood Shake and Shingle Roofs

Finish each shingle or shake roof with a ridge cap that matches the original or is an appropriate substitute, as identified in the condition and historic assessment or by your heritage specialist or archaeologist. No matter what the ridge cap style, always use nails long enough to reach the sheathing or ridge purlin. Before installing any type of ridge cap, provide extra insurance against leaks by laying a strip of self-adhering ice and water shield (slightly narrower than the ridge cap) over the roofing shakes or shingles where they meet at the peak of the roof.

Metal ridge caps (figure 272) and board ridge caps (figure 273) are relatively easy to install. Just nail the cap in place over the top rows of shingles. Make sure to tightly butt together the two boards that make the board ridge cap. Miter the overlapping edges of the boards to match the pitch of the roof for a tight, attractive joint. Ensure that the joint between the two boards is on the lee side of the roof (facing away from the prevailing wind).

Form cock's comb ridge caps by leaving log shingle tails on the windward side that extend above the ridge of the roof. Simply extend the shingles or shakes of the top course about 6 inches above the ridge of the building. Either precut the cock's comb shingles or shakes to the correct length before installing them or use a small saw to trim them along a chalkline after you place them (figure 274).

The upper ends of the shingles or shakes in the top course on the lee side must fit tightly to the extended cock's comb shingles or shakes on the windward side. Cut the top course lee side shingles or shakes to the correct length before installation.

Figure 272—Preservation crewmembers carefully removed and reinstalled the original metal ridge cap after replacing the shingles on the Moose Creek Garage (Helena National Forest, Northern Region).

Figure 273—Although the Sage Creek vault toilet building isn't a log cabin, it does have a shingle roof with a board ridge cap. The outhouse serves the historic log cabin at Sage Creek (Custer National Forest, Northern Region).

Figure 274—This roofer is using a small hand saw to trim the ends of the cock's comb ridge for the replacement roofing on the Moose Creek Wilderness Station Office/Cookhouse building (Nez Perce National Forest, Northern Region). Although the roof that the preservation crew replaced had a shingle ridge cap, historic photos showed that the original ridge cap was a cock's comb. The crew took the opportunity presented by the need for new roofing to restore the original configuration.

You can make the most common ridge or hip cap for log cabins roofed with shingles or shakes from the same shingles or shakes you use for the roof (figure 275). This ridge cap consists of an overlapping series of L-shaped, uniform width, two-shingle units joined together along one edge to create an angle that matches the angle where the two sides of the roof meet at the ridge. Lay them individually along the length of the ridge with the same exposure as the roofing shingles.

You can purchase manufactured ridge cap units, construct them on the ridge, or fabricate them on the ground. You can special order manufactured ridge cap units to match any roof pitch, but they normally are only available in a few shingle and shake styles and wood species. If you purchase manufactured ridge cap units, ensure that half have a right-hand overlap and half have a left-hand overlap so that you can alternate overlaps when you install them. You may not be able to find manufactured ridge cap units that match your cabin's shingles. In this case, you must make your own.

Figure 275—Preservation crewmembers constructed this shingle ridge cap when they replaced the roofing at the Ninemile Ranger Station (Lolo National Forest, Northern Region).

If you make your own ridge caps, choose the width of the shingles or shakes carefully to cover an area that is about 1 inch wider than the length of exposure used on the roof. Because overlapping pairs of shingles or shakes make up the ridge units, half of the shingles or shakes must be wider than the other half by the same amount as the thickness of the shingles or shakes. For example, if you lay 16-inch-long shingles, the standard exposure is 5 inches and the shingles are just shy of ½-inch thick. In this situation, half of the shingles for your ridge cap must be about 6 inches wide and the other half must be about 6½ inches wide to provide proper and equal coverage on both sides of the ridge. You need to fasten one wider and one narrower shingle together to create each ridge cap unit. Build half the ridge cap units to lap to the right and half to lap to the left.

To construct a good, tight overlap joint, set a table saw to the angle of the roof pitch and cut the overlapping edge of the wider shingles to that angle. Then, set the table saw to the angle perpendicular to the roof pitch and cut the underlapping edge of the narrower shingles to that angle. Assemble the cut shingles on the ground or take them up on the roof to assemble them.

To speed the actual on-roof installation, you can build a simple jig that matches the roof peak and you can assemble the shingle cap units on the ground ahead of time. Use an air stapler to fasten the two halves of each ridge cap unit together. Use three staples evenly placed from the butt to the middle of each pair of shingles. Make sure that you set the stapler pressure to drive the staples flush with the surface of the shingle, neither protruding nor indented. This application is the only acceptable use of staples on a shingle.

The following steps explain how to construct a shingle ridge without using manufactured or prebuilt ridge cap units. This example is for a roof covered with 16-inch-long, ½-inch-thick shingles using a 5-inch exposure. Adjust the measurements proportionally to match the length and thickness of your roofing. You will be working on the highest part of the cabin roof, so be sure to follow proper safety precautions to prevent falls.

1. Starting at the lee end of the roof, lay one 6-inch-wide shingle horizontally on your side of the roof with the shingle butt end on the roof's gable end and the top edge of the shingle even with the roof peak. Nail the shingle with two nails, 6 inches from the butt (1 inch plus the exposure).
2. Reach over the other side of the roof and lay a 6½-inch-wide shingle horizontally with the shingle butt on the roof's gable end and the top edge tight against and overlapping (but not overhanging) the top edge of the first shingle, so that the joint faces you. Nail it in place using two nails, 6 inches from the butt.
3. Install the third and fourth shingles the same way, but put the 6-inch-wide shingle on the side of the roof away from you and the 6½-inch-wide shingle on your side of the roof, so that the overlap is reversed and the joint faces away from you. Place the butts of the third and fourth shingles 5 inches closer to the middle of the roof ridge than the butts of the first two shingles.
4. Repeat the process, alternating the direction of the overlap with each ridge cap unit, all the way across the peak of the roof.

A variation of this type of ridge cap reverses the direction of the ridge shingle butts at the middle of the roof peak. To lay this type of ridge cap, mark the middle of the roof peak and then lay the ridge cap shingles as described above from both ends until they meet in the middle. At the middle, interlay four shingles and cap them with a ridge cap unit, spanning the point where they meet. The middle cap shingles will have exposed nails (figure 276). Another variation of this type of ridge cap includes using metal flashing under the ridge cap (figure 277).

Figure 276—Preservation crewmembers constructed this complex shingle ridge cap while replacing roofing on the Zortman Guard Station within the Bureau of Land Management's HiLine District in Montana. The shingle butts switch direction in the middle of the roof peak, and a cross gable also intersects the main ridge line at that point. Because of the cross gable, the crew cut a notch into one side of the ridge cap unit at the middle of the roof.

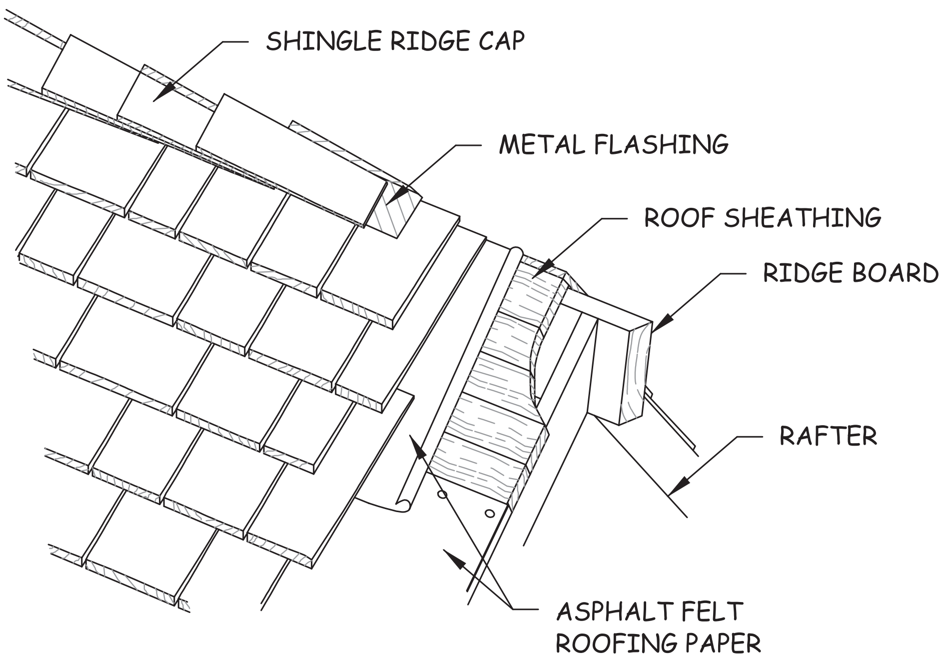


Figure 277—This drawing shows how to add metal flashing under a shingle ridge cap for extra leak protection. The same method works for adding self-adhering ice and water shield leak protection.

Reroofing With Metal

Unless you are replacing generic, corrugated metal roofing, metal roof installation isn't a project for the do-it-yourselfer. Specialized tools and techniques vary with manufacturers and generally require an experienced installer to obtain good results.

The most important thing to understand about metal roofing is that metal expands and contracts with temperature changes far more than other roofing. Fastening systems for metal roofs must accommodate this expansion and contraction or leaks develop as the metal rubs against and expands the holes around the fasteners.

Some metal roofs, such as a standing-seam style, have clip fasteners that handle expansion and contraction by allowing the panels to "float" over the roof structure. Other metal panels have ridges that allow accordion-effect movement between fasteners. Screw-down systems generally rely on elongated fastener holes and gasketed screws to accommodate longitudinal panel expansion and contraction. Other systems rely on combinations of these methods to provide a leak-free roof.

Because of these differences, it is very important to follow the manufacturer's instructions to install metal roofing. For any metal roofing other than corrugated, the best advice is to hire an experienced contractor who understands historic buildings and who the manufacturer has trained to install the roofing you chose. Some contractors will allow you to assist with the work, which helps to reduce the cost. The rest of this section applies only to the installation of corrugated metal roofing.

You are most likely to achieve a leak-free metal roof installation by laying ice and water shield over the entire roof before you install the metal roofing (figure 278) and by using gasketed screws to attach the roofing. Ice and water shield for metal roofs is different from ice and water shield used for other roofs. Look for a label specifying the shield's suitability for use with metal roofs or for use under sustained high temperatures.

Figure 278—Preservation crewmembers are laying a new corrugated metal roof over ice and water shield on the Savenac Tree Nursery Bunkhouse (Lolo National Forest, Northern Region), built in 1930. The roof is the same kind you would find on log cabins of a similar vintage that have metal roofs.

Only lay ice and water shield over continuous sheathing. If the builders originally laid your historic metal roof over purlins or skip sheathing, you may be able to add continuous sheathing so you can install ice and water shield. Doing so will produce a more durable roof, but could lead to condensation or other problems for the cabin if the sheathing is not designed properly.

Before adding sheathing, be sure to consult with an engineer experienced in designing roofs. Without a proper design, adding sheathing could overload the rafters, purlins, or trusses. The engineer must design fastener spacing properly for the type of sheathing on the cabin and for the typical wind uplift at the site. If a Federal or State government agency owns the cabin, or if Federal or State sources provide some or all of the funding for the cabin preservation work, check with your heritage resource specialist or archaeologist to determine if you must consult or seek approval from the SHPO for the change.

Eyeballing a sheet of metal roofing and laying it so that the seams and ridges appear to be perpendicular to the logs of the cabin is very difficult. Use chalklines to simplify aligning the panels. Measure from either the ridge or eave line, whichever is straighter and more nearly level, to mark your chalk lines.

To create guidelines perpendicular to the ridge or eave, use the geometry of right triangles. An easy-to-remember right angle triangle has one leg that is 3 feet long, one leg that is 4 feet long, and a connecting side (hypotenuse) that is 5 feet long. This arrangement is referred to as a 3-4-5 triangle. Larger triangles with the same proportions would be 6-8-10, 9-12-15, 12-16-20, and so on. If you create this sort of right triangle and position the "3" side parallel to the ridge or eave, you can use the "4" side of the triangle to align the long edge of the roofing because it will be reliably perpendicular to the "3" side.

How To Create Perpendicular Guidelines Using a 6-8-10 Triangle

1. Measure 1 foot up from the eave or 1 foot down from the ridge, whichever is straighter, at each end of the roof. Snap a chalkline the full width of the roof.
2. Mark a point on the chalkline near whichever end you plan to start placing the panels.
3. Measure 6 feet along the chalkline and mark a second point.
4. Next, have three people with two tape measures create the other leg and hypotenuse of the triangle.
    a. Have a person hold the zero end of one tape measure at the first marked point.
    b. Have another person hold the zero end of the second tape at the second marked point.
    c. Have the third person hold the other end of the first person's tape at the 8-foot mark and the other end of the second person's tape at the 10-foot mark so that they cross to create a perfect right triangle.
5. Snap a line from the point marked in step 2 (shown as "starting point" in figure 279) to the point where the third person holds the junction of the two tapes. This line is your first perpendicular guideline.
6. Use the same triangular procedure to mark a perpendicular guideline at the other end of the roof. Snap a chalkline from the junction points of the two triangles to create a second horizontal chalkline that is parallel with the line that is 1 foot up from the eave or 1 foot down from the ridge of the roof.
7. As you lay panels across the roof, they will cover your first perpendicular guideline, so mark several perpendicular guidelines. To do this, measure matching distances from your first perpendicular guideline on the upper and lower parallel horizontal chalklines, mark those points, and snap perpendicular chalk guidelines between the matching distance points.

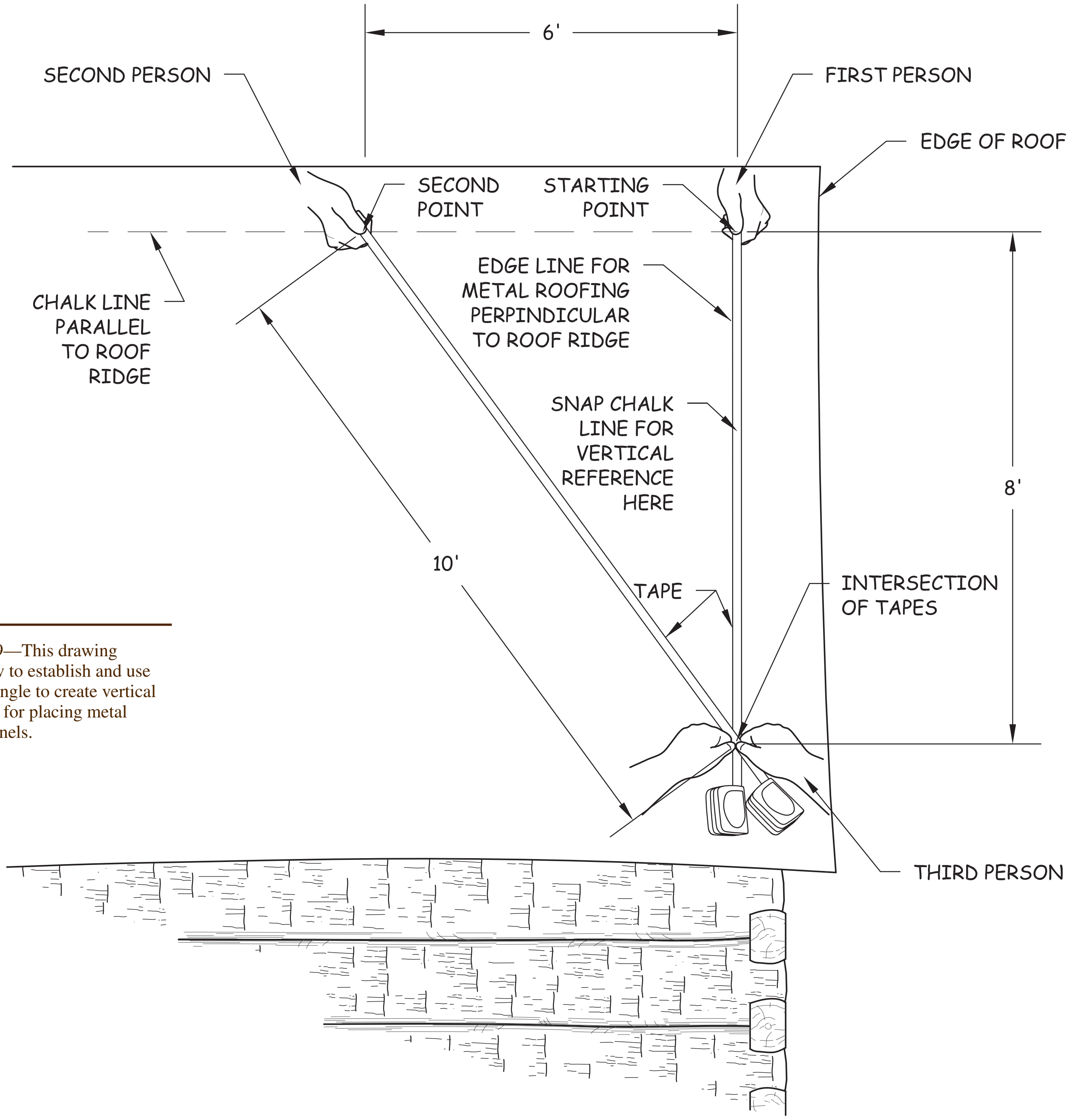


Figure 279—This drawing shows how to establish and use a right triangle to create vertical guidelines for placing metal roofing panels.

Lay each roofing panel so that it aligns with the perpendicular guidelines. Be sure that the overlapping lip of each panel sits properly in its receiving channel (figure 280). Attach the metal roofing to the sheathing using roofing screws that have a flexible rubber or synthetic gasket under the flange. Use the screw spacing recommended by the manufacturer or designed by the engineer. See the Roofing Fasteners and Tools section of this guide for information about using impact drivers and screw placement. Drive each screw tight to the roofing, but not so tight that the rubber washer deforms (see figure 259).

Finish the roofing using a ridge cap that is recommended by the roofing manufacturer and that matches the original or is an appropriate replacement (figure 281). Use precut closure strips that match the roofing corrugation or ribbing at the ridge and eaves to prevent insects and other pests from inhabiting the spaces under the roofing. Use butyl tape to seal side laps and end laps between panels.

Figure 280—For metal roofing, it is very important for the overlapping lip of each panel to sit properly in the receiving channel of the adjacent panel, as shown on this vertical joint.

Figure 281—The ridge cap is the final element that you install on a metal roof. In this photo, the roof is complete, but the preservation crew has not yet replaced the siding on the dormer.

Reroofing With Asphalt Rolls

Rolled asphalt roofing (figure 282) is the easiest type of roofing to install. Rolls typically are 36 inches wide by 33 feet long and weigh about a hundred pounds. Constructing a leak-free roof isn't quite as simple as rolling it out and nailing it down, though. When you order the rolled roofing, get the manufacturer's installation guidelines and follow the directions. If no instructions are available, install the roofing as explained below.

Because asphalt roofing cracks easily in cold weather and is easily disfigured and scuffed in hot weather, install it only when the temperature is between 40 and 85 °F. Store your rolls in the shade if the temperature is more than 70 °F. Because rolled roofing isn't tough material, sweep the roof (or use a leaf blower) before beginning installation to remove debris from the sheathing so the roofing can lay absolutely flat. Stray nails, debris, or protruding splinters from the sheathing will result in holes and leaks.

Next, install underlayment as explained in the Underlayment, Ice and Water Shield, Drip Edging, Rakers, and Cant Strips section of this guide. Consider installing ice and water shield if the cabin has a history of ice damming or leak damage.

Some original asphalt rolled roofs had drip edging. Sometimes builders used T- or L-shaped drip edge, and sometimes they used drip edging with a C-shaped channel for the asphalt roofing to slip into. Using the C-shaped channel drip edge results in a more durable roof because it protects the edges of the asphalt roofing from fraying. If the cabin builders didn't originally install C-channel drip edge, adding it will change the cabin's appearance. A change of appearance may trigger a requirement for review or approval by the SHPO if a Federal or State government agency owns the cabin, or if Federal or State sources provided some or all of the funding for the cabin preservation work. Check with your heritage resource specialist or archaeologist for the requirements. If you use drip edging, install it as explained in the Underlayment, Ice and Water Shield, Drip Edging, Rakers, and Cant Strips section of this guide.

Figure 282—These roofers are replacing the old asphalt rolled roofing at Hogback Cabin (Lolo National Forest, Northern Region). The roofing had deteriorated along the unusual vertical seams. Roofers usually lay asphalt rolled roofing with horizontal seams.

If the rolled roofing is the standard 36 inches wide, saw a roll or a partial roll in half to make 18-inch-wide starter strips on a cool morning or evening (under 60 °F). Even when it is cool, the asphalt will gum up the saw blade and the granules will dull it, so don't use your good circular saw blade for this work. If you can't saw a roll to make starter strips, cut them with a roofing knife. This will take a while, so plan accordingly. You'll need enough length to go completely around the perimeter of the roof, plus the full length of any valleys.

Apply a 2-inch-wide stripe of roofing cement along all edges of the roof and lay the starter strips on top of the cement. If the roof has no metal drip edge, apply the starter strips so that they overhang the sheathing by about ½ inch. Run a roller over the strips to ensure that there aren't any air bubbles under the strips and that the strips fully contact the roofing cement. Nail down the strips about 1 inch from both edges (1½ inches from edges that overhang the sheathing) using the fastener spacing recommended by the manufacturer. Use roofing nails specifically designed for use with asphalt roofing—the ones with broad heads, not the box nails used on wood shingle roofs. Overlap any vertical joints by 6 inches and use roofing cement between the layers. At the corners, fully lap the gable end starter strips over the eave starter strips and use roofing cement to adhere the layers.

Next, apply 17- to 18-inch-wide rolled roofing strips bedded in roofing cement for the full length of any valleys on the roof. Roll the valley strips to remove any air bubbles and nail them down with roofing nails using the same procedure you used for the starter strips.

Where a vent protrudes through the roof, cut a hole for the vent in the middle of a 24-inch-square roll of asphalt roofing. Apply roofing cement to a 24-inch-square area around the vent. Slip the roofing over the vent, roll it to remove bubbles, and nail it in place. Space the roofing nails about 3 inches apart around the edges. Follow the normal flashing procedures explained in the Flashing section of this guide as you lay the main field of the roofing.

Duplicate the pattern of the original roofing for the main field of the roofing, unless it is obviously deficient. Because the original builders laid most rolls horizontally, that process is explained here. Some builders originally laid asphalt rolled roofing vertically. Modify the process if your cabin has vertical roofing strips.

Starting at the eave, snap a chalkline the width of the roll above the eave, minus the overhang width. This line serves as a reference for aligning the top edge of the first course of rolled roofing. Apply a 2-inch-wide strip of roofing cement to the eave edge of the starter strip and then roll the first row of roofing out over the entire width of the roof. Allow the ends to hang over the gable end about 1 inch, unless you are using "C" channel.

If you are using "C" channel, tuck the gable end edges into the "C" slot. Make sure that the entire length of the roll lays flat on the roof and then nail it in place, spacing the roofing nails about 4 inches apart and about 1 inch in from both the top and bottom edges. If the roll isn't long enough to extend the full width of the roof, apply roofing cement in a 2-inch strip over the short end. Overlap the next roll 6 inches and nail it in place as you would the edges of each roll. Seal these vertical overlap seams with roofing cement.

On each gable end, measure up from the top edge of the first roll of roofing the width of the roofing roll minus 6 inches. Snap a chalkline between the two points. Apply roofing cement to the top 6 inches of the first row of roofing. Using the new chalkline as a guide, roll the second row of roofing out over the entire width of the roof, overlapping the first row 6 inches (the width of the roofing cement). Make sure that the entire length of the roll lays flat. Nail it in place, as you did with the first row. Continue this process all the way to the peak of the roof, then use the same process on the other side of the roof.

If you use a premanufactured ridge cap, install it according to the manufacturer's instructions. If not, make a double overlap ridge cap by lapping the final row of asphalt roofing at least 6 inches over the peak of the roof and down the opposite side. Apply a 2-inch-wide layer of cement under the far edge before securing the material in place. Repeat the same process on the other side of the roof (figure 283).

To finish the gable end edges of roofs without "C" channel edging, measure ½ inch beyond the gable end edges of the sheathing at the eave and ridge on both sides of the roof, then snap a chalkline. Use a sharp knife to trim the edges of the roofing along the chalkline.

Figure 283—The ridge cap for the asphalt rolled roofing at Hogback Cabin consists of two 12-inch-long overlaps at the peak of the roof. Matching the original pattern, the preservation crew overlapped each roofing roll from the back of the cabin 12 inches past the ridge onto the front roof. They then overlapped each roll from the front of the cabin 12 inches past the ridge and secured it on top of the roofing on the back of the cabin.

Reroofing Using Asphalt Shingles

Installing asphalt shingles on the simple gable roof of a one-story cabin is pretty straightforward. It can be pleasant work if the weather is mild, but problematic when the weather is either too hot or too cold. As with asphalt rolled roofing, asphalt shingles crack easily in cold weather. The seal tab adhesive (tack strips) won't adhere properly in cold weather. Asphalt shingles are easily disfigured and scuffed in hot weather. Despite the plastic separation strips, the seal tabs tend to bind together in the bundles if the weather is excessively hot, making it hard to separate the shingles.

Although organic base asphalt shingles are a little more flexible than fiberglass base asphalt shingles, install either type only when the temperature is between 40 and 85 °F. Install asphalt shingles early enough in the season to expose them to several days of hot weather before winter sets in so the self-sealing adhesive spots will adhere properly before the first winter storm hits.

As with asphalt rolled roofing, sweep the roof (or use a leaf blower) to remove debris before you install the shingles. Visually check for and remove protruding splinters or nails that could poke holes in the roofing and cause the roof to leak.

Standard asphalt shingles seldom include detailed manufacturer's installation instructions because these shingles are so common. Manufacturers usually do include installation instructions for specialty asphalt shingles, such as interlocking shingles. Installing specialty shingles is a little tricky, but proper installation is essential for the roof to perform satisfactorily. If you have manufacturer's installation instructions, follow them. If not, use the following installation procedure.

Install asphalt shingles starting at the eaves and work up to the ridge in horizontal rows, as with all shingles. Install the shingles by starting either at the middle or on one gable end of the roof.

After you install the underlayment and drip edge (if any), lay a starter course across the eave edge of one side of the roof. Use precut starter shingles or cut the tabs off regular shingles to create your own starter shingles. Be sure to orient the starter shingles so that the adhesive spots face up along the eave edge (figure 284). Do not flip full-size shingles and nail them down as a starter course; the adhesive spots won't be in the correct position to secure the first full course of shingles against windy conditions. Because of wind patterns around a building, the first course of shingles is the most susceptible to wind lift and ripping if you don't secure the shingles properly.

When you use standard 12-inch-wide shingles, your starter course shingles will be 7 inches wide and 36 inches long after you cut off the tabs. Mark a spot 6½ inches up from the eave on each gable end of the roof and snap a chalkline across the roof between these two points. This line marks the top edge of the starter course.

Next, if you're shingling from the middle, mark the exact middle of the roof with a vertical chalkline that extends from the eave to the ridge. Center the first starter shingle on the chalkline. Lay the rest of the starter shingles in a line that extends in both directions to each gable end and cut off the end shingles so that they extend ½ inch beyond the gable ends.

If you are shingling from the gable end, begin with a 6-inch-long piece cut from a starter shingle and lay it so that the edge extends ½ inch beyond the gable end of the roof. Lay full-length starter shingles in a line down the length of the eave, cutting off the edge of the last starter shingle so that it extends ½ inch beyond the gable end.

Align the top of each starter shingle with the horizontal chalkline so that the bottom of each shingle extends about ½ inch beyond the eave edge. Attach each full-length starter course shingle with four roofing nails in a line directly above the adhesive spots.

Install the first full row of shingles over the starter course. Assuming that your shingles are the standard 12 inches wide, mark a spot on each gable end of the roof that is 11½ inches from the eave edge and snap a horizontal chalkline between

Figure 284—As shown in the lower right of this photo, roofers created an asphalt shingle starter course for the roof of this historic log cabin by cutting the tabs off regular shingles. Note the position of the adhesive spots near the eave edge of the shingles. The original builders constructed the log part of the cabin, known as "the Homestead," in the early 1800s on what is now the Bradford District (Allegheny National Forest, Eastern Region). The owner added frame wings in the early 1900s.

the points. Use the chalkline to position the top of each shingle. This will assure that the bottom edge of the starter course and first full row of shingles are aligned.

If you are shingling from the middle, lay one full shingle on either side of the vertical chalkline so that the joint between them aligns with the vertical chalkline. Lay the rest of the row in both directions to the gable ends.

If you start at a gable end, start with a full shingle and lay the row straight across to the other gable end.

Attach each shingle with four roofing nails. If your shingles have three tabs, place a nail about ½ inch beyond the top of each shingle slot, including each end slot. Drive the nails above the end slots about ½ to 1 inch from the edge of the shingle. If the shingles aren't slotted, drive the nails about 6 inches above the bottom of the shingles if they have the standard 5-inch exposure.

Whether the shingles are tabbed or not, ensure that the row of nails is directly below the sealer spots. Do not nail even with or above the sealer spots or you will deprive the underlying layer of shingles of its second row of fasteners and reduce the intended fastening strength of the roof by one-half. Drive the nails flush, but do not dent the shingle. Improperly set nails will cause premature roof failure when the shingles tear around the nails or crack above them.

If you last installed asphalt shingles a number of years ago, you may be surprised to notice that the plastic separator strips stick to the underside (rather than the top) of each shingle as you remove the shingles from the bundle. You don't need to remove separator strips that stick to the undersides of the shingles. If the separator strips stick to the adhesive spots on the tops of the shingles, remove the strips before you place the next course of shingles over the spots or the shingles won't adhere properly.

If the roof is extremely steep, more than 1½ times as much rise as run to the roof slope (18/12), the adhesive spots may not set up properly. On these very steep roofs, apply additional adhesive by hand under each corner of each tab overlap.

Next, if the shingles have a standard 5-inch exposure, mark both gable ends at 5-inch intervals all the way to the ridge, starting from the top of the first row of shingles. Snap chalklines between the marks. Use the chalklines to position the top of each row of shingles. If the roof isn't square, slightly adjust the measurement on one side of the roof for several courses until the measurements are even. Do not adjust more than ½ inch on any course, or it will be visible from the ground.

You can finish the shingling after you mark the rows. Use the same process used on the first row, but offset the shingles in each row 6 inches horizontally from the layer below so that the slots don't line up and expose the nails of the row below. If you are shingling from the center of the roof, simply move the edge of the middle shingle 6 inches to the left on each succeeding row. If you are starting from the gable end, cut 6 inches off the gable end of the first shingle on the second row, 12 inches off the first shingle on the third row, and 18 inches off the first shingle of the fourth row. If you cut each shingle carefully, you can use the 12 inches cut off the first shingle for the third row to start the fifth row and the 6 inches you cut off the first shingle for the second row to start the sixth row.

You can either complete each full course of shingles before installing the next course, or you can install the shingles in a stair step pattern (figure 285). Start at a gable end to install shingles in a stair step pattern. Lay the end shingles (trimmed to length) of the first six rows. Next, lay a full-size shingle in each of the first six rows, starting at the bottom, and add a full-size shingle to start the seventh row. Lay the next full-size shingle in each of the seven rows, starting at the bottom, and begin the eighth row by adding a shingle with 6 inches cut off the gable end. Work up and diagonally until you cover the roof from eave to peak.

Extend the top row of shingles a couple of inches above the peak of the roof. Do not add another row if the shingles will extend more than 5 inches above the peak. Fold the extra shingle length over the ridge and nail it down using four roofing nails per shingle. This provides extra protection against leaks at the roof ridge. Then, repeat the process on the other side of the roof.

Do not install shingles in vertical rows, sometimes referred to as vertical racking. If you install shingles in vertical rows, it will be nearly impossible to nail under the edges without

Figure 285—When the roofers replaced the roof on this 1936 residence, they applied asphalt shingles in a stair step pattern. Roofing nails are visible near the right edge of each tier of shingles. The building, located just north of Lincoln City, OR, is part of the Pacific Northwest Research Station's Cascade Head Experimental Forest.

damaging the shingles. You are almost certain to damage the shingles as you bend back alternating course edges to install adjacent shingles. Vertical racking leads to premature roof failure. It also often produces unattractive vertical stripes on the roof because of variations in color between shingle bundles.

After shingling both sides of the roof, install the ridge shingles. Do not use the premanufactured ridge vents that people commonly use on modern asphalt shingle roofs. Ridge vents have been around since about 1980; they aren't appropriate for cabins built before that time. Builders who constructed cabins between about 1930 and 1970 and used asphalt shingles on the roof nearly always vented the attic through the gable ends. Maintain this venting method. If the attic shows signs of moisture or condensation problems, consider using larger gable vents that appear similar to the existing gable vents.

Follow the manufacturer's directions if you use precut ridge shingles. To make your own ridge shingles, cut regular three-tab roofing shingles apart at each slot to make three 12-inch-wide ridge shingles from each roofing shingle. Taper the sides of the top half of each shingle slightly to produce a neat profile and to keep the lap portion of each shingle hidden from view on the finished ridge cap.

You may install ridge caps from both gable ends toward the center, or orient them all in the same direction with the overlap facing away from the prevailing winter wind (if any). Install the ridge cap shingles by bending them into place over the ridge and fastening them with one roofing nail on each side of the ridge. Use slightly longer nails on the ridge shingles to penetrate the extra shingle layers and the sheathing. Install ridge shingles with the same exposure as regular shingles and nail them directly below the adhesive spots, exactly as you would with regular shingles. Cover the exposed nails in the last ridge shingle with roofing cement to prevent leaks.

Install hip ridge shingles using the same method as the main ridge shingles, but install them before you install the main ridge shingles. The main ridge shingles must cover the top of the hip. Slit the final hip shingle at the top where it meets the ridge, fold it over the ridge in both directions, and nail it in place using one nail on each folded piece in addition to the nails below the adhesive spots. You may need to trim the top hip shingle so that the main ridge shingle installed over it hides the folded-over ears (figure 286).

Application procedures for asphalt shingles are critical. It is true that nearly everyone who has worked in residential construction is familiar with asphalt shingle roofing procedures. It also is true that nearly anyone can successfully apply an asphalt shingle roof. However, the roof's performance will be disappointing if you don't carefully install it, so don't get sloppy or cut corners.

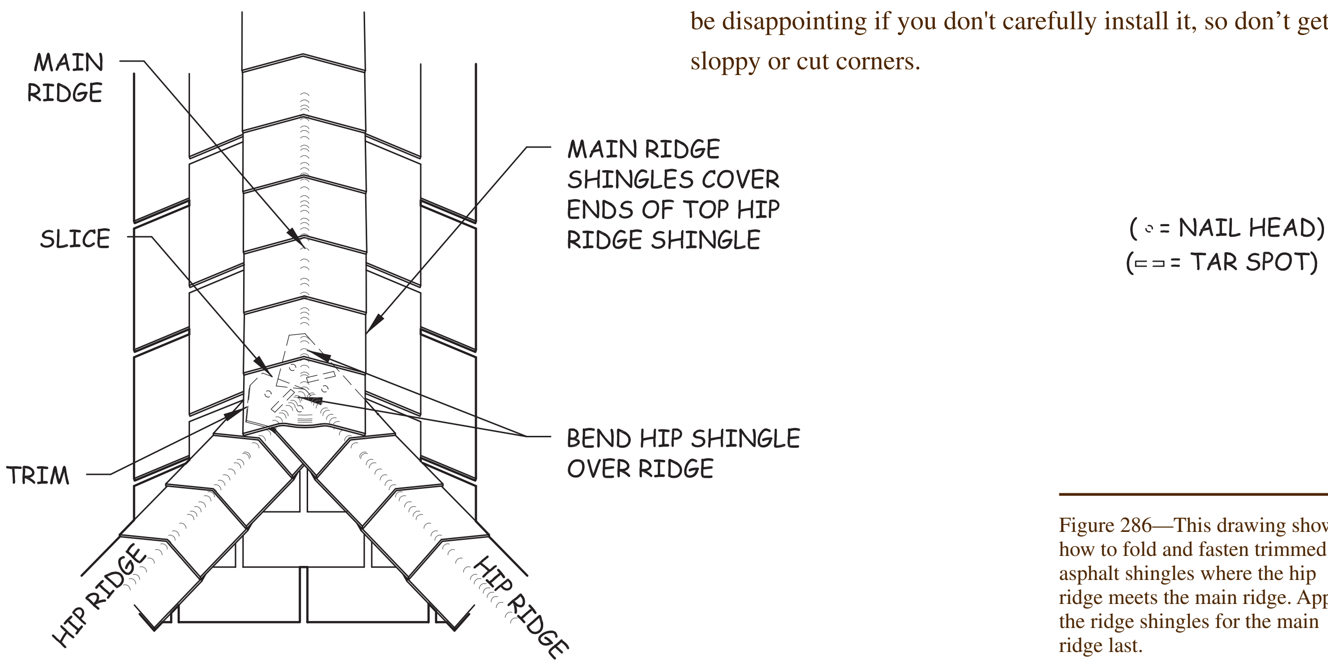


Figure 286—This drawing shows how to fold and fasten trimmed asphalt shingles where the hip ridge meets the main ridge. Apply the ridge shingles for the main ridge last.

Reroofing Using Sod

Sod roofs are surprisingly durable. The sod and drainage layers of historic sod roofs (figure 287) required replacement every few years, but engineered vegetated roofs can last for 20 years or more before requiring significant repair. Unless you have the resources to continually replace the sod and drainage layers, you probably want to replace your historic sod roof with an engineered vegetated roof, or at least use modern waterproof and drainage layers. Use vegetation similar to or the same as that on the historic roof, if possible.

An engineered vegetated roof consists, from the bottom to the top, of:

1. **Roof structure—**Ensure that the historic roof structure is sturdy enough to hold the sod, which can weigh from 15 to 50 pounds per square foot when fully saturated, depending on soil depth and absorbency.
2. **Waterproof layer—**Prevents water from leaking through the roof and prevents root penetration into the roof structure. Products available range from heavy duty single-ply sheet roofing to roll- or spray-on waterproofing.
3. **Drainage layer—**Enables water not absorbed by the soil and plant roots to drain from under the soil and be channelled away from the roof. Products range from open-graded gravel or lightweight aggregates, to geotextiles, to drainage materials that are specially designed for vegetated roofs. These drainage materials allow the roof to store some water and drain the rest.
4. **Soil layer—**In contrast to the historic practice of cutting sod from the prairie and placing it on the roof, modern growth media is lightweight and designed to retain moisture, drain excess water, provide and absorb nutrients, and anchor plant roots. The media usually contains perlite, vermiculite, or light expanded clay granules, as well as native soil and organic additives.
5. **Vegetation—**Depending on the thickness of the soil layer and the local climate, plants that do well on green roofs include stone crop *(Sedum),* ice plant *(Delosperma)*, hens and chicks *(Sempervivums),* pinks *(Dianthus),* thyme, alyssum, sedge, and native grasses and shallow-rooted forbs. Be sure to choose hardy, drought-resistant species acclimated to your area.

Figure 287—The large sod-roofed Cunningham cabin in Grand Teton National Park, constructed in 1888, is one of the earliest homesteads in Jackson Hole. The cabin is listed on the National Register of Historic Places and is maintained as part of a large homestead used to interpret the area history.

Constructing an engineered vegetated roof that will last a long time and won't leak isn't particularly difficult if you engage knowledgeable professionals to design it, but you must execute the details properly. Hire a structural engineer (if needed) and a green roofing expert, such as a landscape architect, to design the roof. You may need prior input to or approval of the design by the SHPO if a Federal or State government agency owns the cabin, or if Federal or State sources provide some or all of the funding for the cabin preservation work. Check with your heritage resource specialist or archaeologist for the requirements. In some cases, engineered soil layers may be acceptable. Historic considerations may necessitate using sod cut from adjacent soils in other instances.

Consider hiring an experienced contractor to install or help you if you are installing an engineered vegetated roof. Many modern systems have specialized installation requirements; you must complete the work exactly as detailed on the plans to avoid premature roof failure and leaks.

The process for installing a sod roof that includes modern waterproof and drainage layers but closely resembles a historic roof is fairly straightforward. Following the manufacturer's instructions and the engineer or landscape architect's design, lay ice and water shield and then geotextile drainage fabric over the sheathing. If you will use native sod, cut squares or strips of good, solid, healthy sod to roughly the same thickness as the historic sod, but never less than 4 inches thick. Lay the sod on the roof, butting the individual pieces tightly together and using small scraps to fill any voids between pieces. Form and install a ridge cap of sod or boards to match the original. Replace any log or board borders around the roof (see figure 1). Next, water the sod sufficiently to thoroughly soak the soil. Unless precipitation provides plenty of moisture, water the sod regularly for the first year after installation to ensure its survival.

Of course, this guide provides only a general description of the process. Many variations are possible and may be reasonable, depending on the building and climate. For instance, when roofers replaced the sod roof on the Alta Ranger Station, they installed a layer of ethylene propylene diene monomer (EPDM) over the plank sheathing, then a layer of geocell fabric to hold the soil in place. EPDM is an inert synthetic rubber with excellent heat, ozone, and weather resistance. It commonly is used for many products, including sheet roofing and pond liner. The native soil the roofers cut from the prairie to use as sod was so porous that it didn't require a drainage layer, but the roofers installed a drain between the sod and the retaining log (figure 288). Unfortunately, 2 inches of soil over the geocell did not insulate it well enough. The geocell overheated, warped, and emerged from the soil (figure 289). Be sure that your vegetated roof design will function properly in your climate area.

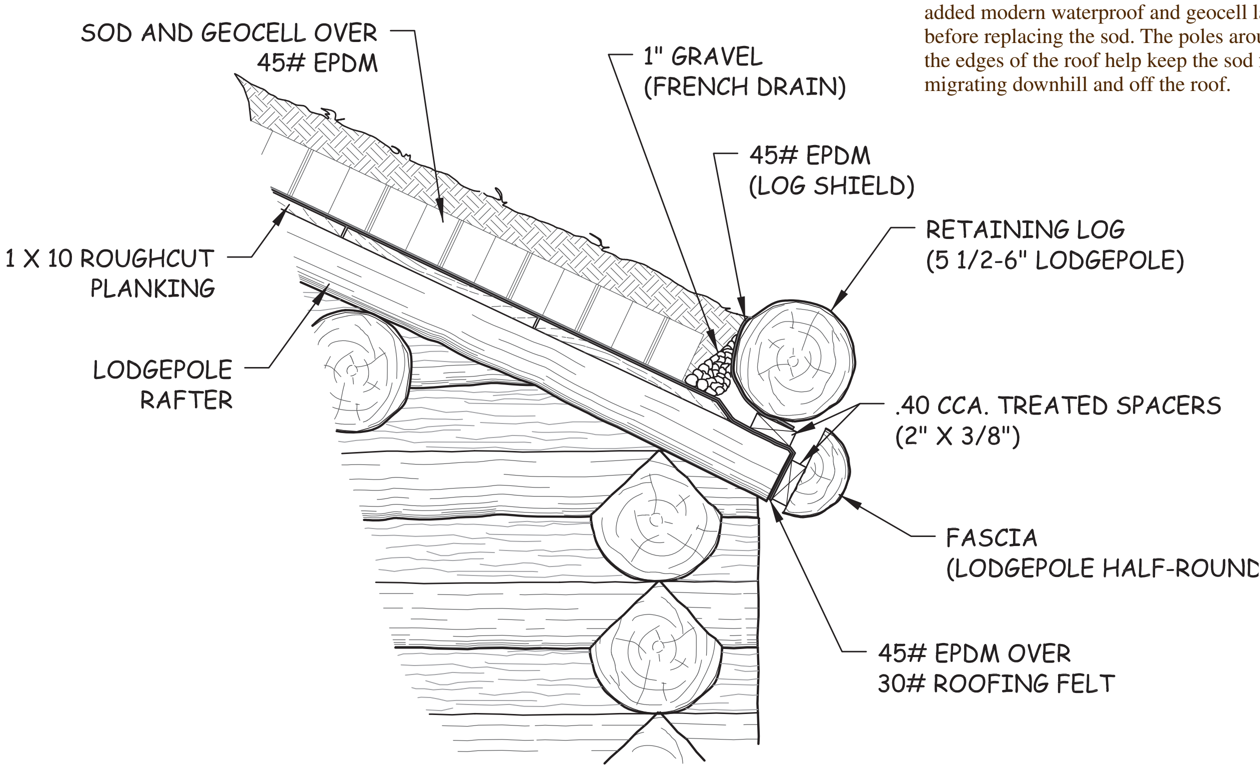


Figure 288—This sketch shows the materials the roofers used to replace the sod roof on the Alta Ranger Station (Bitterroot National Forest, Northern Region), constructed in 1899. They added modern waterproof and geocell layers before replacing the sod. The poles around the edges of the roof help keep the sod from migrating downhill and off the roof.

Figure 289—When preservation crewmembers replaced the sod roof of the Alta Ranger Station, they put down a layer of ethylene propylene diene terpolymer (EPDM) over the puncheon sheathing, then laid geocell to hold the soil in place. Unfortunately, the crew had to remove the geocell fabric after it warped and emerged from the soil.

Preserving Logs

A log cabin is pretty durable (figure 290), especially if its logs are rot resistant. It takes a long time for a log cabin, even an abandoned one, to completely melt into the landscape. Unfortunately, though, once decay sets in, a cabin will be uninhabitable in just a few years unless someone replaces the decayed logs or halts the decay in the very early stages. Take steps to ensure that insects and fungi don't destroy the work you put so much effort into, especially in humid climates.

Treating logs with wood preservatives isn't an appropriate substitute for ensuring that the ground slopes away from your cabin for drainage and that the cabin foundation holds the logs above the ground. Restore the cabin properly and use preservatives only as supplemental protection.

The publication, "Preservative-Treated Wood and Alternative Products in the Forest Service" <http://www.fs.fed.us/t-d/php/library_card.php?p_num=0677 2809P> explains the types of commercially available preservatives and the conditions under which their use is effective. The publication, "Guide for Use of Wood Preservatives in Historic Structures" <http://www.fpl.fs.fed.us/documnts/fplgtr/fpl_gtr217.pdf> addresses concerns about the preservation requirements and physical properties of historic log cabins when using wood preservatives. Most wood preservatives are unsuitable for use on cabin logs because the preservatives are toxic and change the color of the wood. Toxicity is a problem because most cabin interiors have log surfaces. People touch the logs and breathe vapors given off by the preservatives.

Manufacturers recently developed less toxic preservatives. In particular, some preservationists favor the use of borate preservatives. Borate is a water-soluble preservative that penetrates wood through osmosis. This characteristic is valuable because borate migrates readily into areas where high moisture content can lead to decay and insect infestations. It provides relatively nontoxic protection against wood-destroying beetles, fungus, and termites (upwards of 20 to 50 years), and it helps increase the fire resistance of the wood. Borate protects logs near ground level from wood-destroying beetles, termites, and fungal decay related to high humidity conditions. Because borate is water soluble, its protection will be lost if water flushes it from the wood.

Figure 290—The Nothnagle Log House in Gibbstown, NJ, built around 1638, may be the oldest surviving log cabin in the United States. The original hewn-log cabin is 16 by 22 feet, with full dovetail notching, local clay daubing, and a brick fireplace in one corner. The owner constructed the two-story frame addition in the early 1700s. The building still serves as a home.

You can apply borate to the log surface, inject it, or insert dry borate rods into holes drilled into the wood. To use borate rods, drill holes into the logs inside the building using the borate rod manufacturer's recommended spacing. Borate swells when wet, so make the holes larger than the rods. After inserting the borate rod, fit a wood plug into the hole, plane the plug flush with the log, and finish the surface to match the rest of the log if necessary. Borate rods remain inert until they get wet, and then they disperse through the wood to protect it from fungus. Borate rods may not protect logs from insects in dry climates, because they may not become wet and disperse into the wood.

You can mix liquid borate preservative with some water-repellent concentrates. Check the manufacturer's information before mixing preservatives and water repellants. Forest Products Laboratory (FPL) research suggests that you should apply water repellant every 2 to 3 years to any wood protected by borate that is exposed to the weather. As with all preservatives, read and follow the manufacturer's application instructions and suggestions for personal protection.

Using Paint, Stain, and Oil

Color is one of the strongest influences on people's perception and is an important part of log cabin preservation. Restoring the original color(s) can greatly enhance the historic character of the cabin, inside and out (figure 291).

Do not apply paint or clear coatings to surfaces that didn't originally have paint or coating. Paints and clear coatings cover and change the appearance of logs or roofing, damaging the historic integrity of the structure.

You may use FPL log oil to treat logs and wood roofing that didn't historically have treatment because color changes are temporary. As wood ages, it dries out, cracks, and becomes less water resistant and more susceptible to rot and damage. Treating the logs and wood roofing from time to time with FPL log oil extends the life of the wood and causes only a temporary change in color. See more detailed information about the FPL log oil formula later in this section.

Figure 291—The Deadwood storage building (Boise National Forest, Intermountain Region) shows the original brown-stained logs, green-stained roof, and light brown-painted trim.

The Forest Service used standard paint colors at different times within most of its regions. Check your region's historical facilities files to see whether your region used standard colors at the time your cabin was built. If so, information in the files may help you to better match the original paint. If not, it probably used colors that could be described using the Federal color specifications in place at the time of construction. You can order Federal Standard 595C color fan decks and other paint color matching products and specifications from FedSpecs.com <http://www.fed-std-595.com/>.

Unfortunately, lead-based paint covers many historic surfaces. Lead-based paint may be the surface layer or may be buried under post-1978 paint that doesn't contain lead. Even if you remove the lead-based paint, some of the lead may have soaked into and remained in the wood. Fortunately, lead-based paint in good condition usually is not a hazard, and you can seal old lead-based paint or lead remaining in wood away from normal human contact by properly preparing the surface, then applying new primer and latex paint over it.

Exposure to lead results in human health problems. Don't treat maintenance work on lead-based paint surfaces casually. You must take special precautions any time you cut, sand, drill, strip, or do anything else to disturb lead-based paint or lead that has soaked into the wood. More information about determining the presence of lead-based paint, working with materials coated with lead-based paint, and properly disposing of lead-based paint debris, such as paint chips, dust, or sludge is available in the lead-based paint section of the Forest Service's Facilities Toolbox <http://www.fs.fed.us/eng/toolbox/haz/haz03.htm> and in the U.S. Environmental Protection Agency (EPA) web page "Lead in Renovation, Repair, and Painting" <http://www2.epa.gov/lead/renovation-repair-and-painting-program>.

Stricter rules apply when children regularly use buildings with lead-based paint. See the Forest Service Facilities Toolbox section on required lead-based paint removal <http://www.fs.fed.us/eng/toolbox/haz/haz34.htm> for guidance on when you should remove lead-based paint from buildings that may be occupied by children. You must use certified renovation firms or renovators with accredited training who follow the work practice requirements found on the EPA web page "Lead: Lead Renovation, Repair and Painting Program Rules" <http://www2.epa.gov/lead/lead-renovation-repair-and-painting-program-rules> when you conduct renovations that disturb lead-based paint in these buildings.

Remove deteriorated paint, whether lead based or not, before you begin repairs or repaint. Before stripping any paint, take the time to determine the historic paint (figure 292), stain, or sealer color and type so that you know which finish to use. You may be able to find the original finish by gently and carefully sanding through the paint to expose all the layers down to the wood. Sand a shallow circle several inches in diameter. Sand progressively deeper toward the center to expose all the layers of paint in concentric circles. This process is explained on the "Historic Media: Finding the Original Colors of My House" web page <http://www.oldhousecolors.com/2007/01/18/finding-the-original-colors-of-my-house/>.

If sanding doesn't clearly reveal the original finish or you need a more precise determination, have a heritage consultant take samples and inspect them under a microscope. Remember that the old paint may contain lead; take proper precautions.

You can remove paint in a number of different ways. Mechanical methods include machines that have little blades or bits that spin to remove the paint (figures 293 and 294), sanders, and wheels or abrasive pads. Heat methods include heat guns and infrared units. Steam methods include portable garment steamers and steam ovens. You can find chemical strippers in a variety of strengths and formulas, and hand scrapers in many different sizes and shapes.

Each paint removal method has its pros and cons. Sanding, scraping, and mechanical strippers create dust. You can attach a vacuum to some machines and sanders to minimize the dust. Heat methods can char fragile wood. Steam creates no dust, but it is a slower method. Chemicals can be caustic—read and follow the label directions carefully.

Figure 292—Preservation crewmembers repainted the original seafoam green color on the fiberboard bathroom walls they repaired at the 1933 Adams Ranger's House (Nez Perce National Forest, Northern Region).

Figure 293—A power paint stripper, such as this Metabo model, can really speed up the process of removing deteriorated paint.

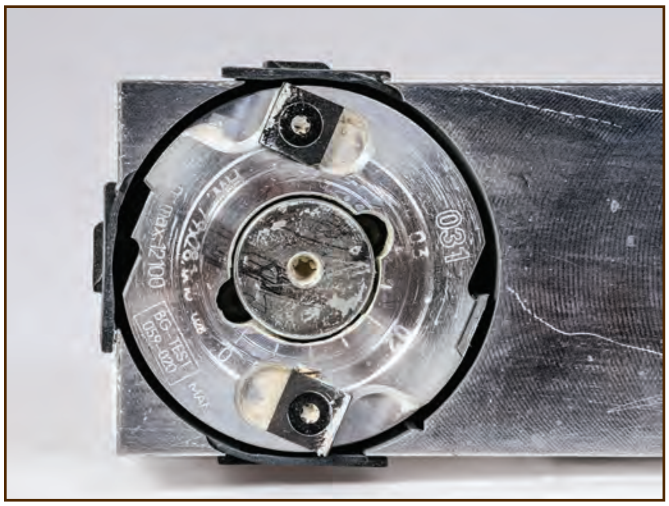


Figure 294—The rotating head of this Metabo paint stripper has tiny blades that peel very thin layers off the painted surface.

A combination of techniques, such as first using steam to remove most of the paint, then scraping and sanding to remove the rest, usually is the most effective. The most effective method depends on the type of paint, the condition of the paint, and the condition of the substrate. For example, the paint on the north side of a building may be difficult to remove, but the paint on the south side may be easy to remove because of weathering. You may need to perform some experiments to find the most effective method for removing paint from your siding, window, door, etc. Information on the steam removal process is available on the John Leeke's Historic Homeworks website <http://www.historichomeworks.com/hhw/reports/reports.htm#steam> and the Olde Window Restorers Portable Steam Paint and Putty Stripper web page <http://www.oldewindowrestorer.com/steamstripper.html>.

Even if the paint contains no lead, wear a mask while you're removing paint so that you don't get the dust or chemicals into your lungs. If the paint contains lead, you need to take more extensive precautions.

Forest Service direction prohibits Forest Service employees from purchasing or using oil-based paints for most purposes. The resins, solvents, pigments, and additives in the liquid paint or stain can be toxic when breathed or touched. The EPA requires that you dispose of any leftover paint as a hazardous material. More information about using oil-based paint for Forest Service buildings is available at <http://www.fs.fed.us/eng/toolbox/haz/haz40.htm>.

Newer oil-based formulas tend to be thicker and less durable than oil-based paints manufactured many years ago because the formulas have changed in response to regulations limiting the off-gassing of volatile organic compounds. You can still find high-solvent paint; it usually is labeled as "quick-dry enamel," "industrial maintenance coating," or "marine paint." These formulas are appropriate for some uses. In addition, you may need to use oil-based primer coats under some circumstances, such as when you repaint over old oil-based paint.

You can find high-quality latex paints that perform as well as or better than oil-based paints for most uses nearly everywhere. Keep in mind that the more expensive, all-acrylic latex generally performs better than less expensive latex with vinyl acrylics. The FPL recommends latex paint for nearly all applications except exterior use over some old oil-based paint. When you paint doors, windows, or cabinets, keep in mind that modern latex paint doesn't produce as hard a finish as older oil-based paint formulas. When you use latex paint on door, window, or cabinetry components, allow it to dry and cure thoroughly before reassembling items or closing doors or windows so that adjacent surfaces don't stick together.

Preparing surfaces properly and ensuring the compatibility between the paint primer and topcoats are both critical to a durable paint job. If a solvent in the topcoat is incompatible with the primer coat, the primer may dissolve or wrinkle or the two layers may fail to adhere to each other. If the primer and topcoat don't adhere well, the top layers will crack, peel, and fall off prematurely. For more information about properly preparing surfaces to receive paint, see the FPL publication "Why House Paint Fails" <http://www.fpl.fs.fed.us/products/publications/specific_pub.php?posting_id=1024&header_id=p>.

You can find stain with either an oil- or latex-base and in semitransparent and semisolid/opaque formulas. Semitransparent stains allow the wood grain to stand out while coloring and protecting the wood. Semisolid/opaque stains completely cover the wood grain. Both types of stain penetrate the wood better than paints do.

Opaque stain seldom is appropriate for historic cabins, because it wasn't available historically. If someone used stain on a historic cabin, the stain most likely was oil-based, semitransparent. If the stain on the surface is visible but faded, restain the surface using an oil-based semitransparent stain that matches the original as closely as possible. Latex stain won't penetrate properly if the old, oil-based stain remains on the logs. If the stain is deteriorated to the point that most of the wood is bare or if you strip the stain from the surface, use a latex semitransparent stain that closely matches the original color.

Some owners whitewashed their buildings (figure 295). To maintain the historic appearance, reapply whitewash to these buildings every few years. The Internet has a number of recipes for whitewash, but the Northern Region Historic Preservation Team prefers the recipe in the box on the next page. This recipe covers about 4,000 square feet with one coat.

Figure 295—Whitewash covers these log buildings at Bill Menor's ferry and homestead in Grand Teton National Park, as it has since the late 1800s. A replica ferry still operates, and the current owner outfitted the log buildings as a country store, similar to the store the original owner operated.

Northern Region Whitewash Recipe

After you develop your job hazard analysis, assemble your ingredients and personal protective equipment. Applying whitewash is messy, so wear disposable clothing, gloves, and safety glasses.

1. Mix 50 pounds of hydrated Type S lime with 6 gallons of water. Let the mix sit overnight.
2. Mix 5 pounds of calcium chloride (CaCl) with 5 gallons of water. CaCl is used to absorb oil spills from concrete floors and is available at automotive supply stores.
3. Mix the two solutions together.
4. Apply whitewash using brushes.

People sometimes used tung oil or linseed oil to produce a natural protective finish for historic interior woodwork. Tung oil and linseed oil penetrate into the wood and then harden. Many commercially available tung oil products aren't pure tung oil, but contain resins and solvents in addition to the tung oil. Polymerized tung oil goes through a heating process; it is preferable for most uses because it dries faster. Linseed oil is available in raw and boiled types. Raw linseed oil takes many weeks to cure, so boiled or heat-treated linseed oil is a better choice for most uses.

People commonly used varnish or shellac as a transparent protective surface coating for historic interior woodwork. You still can find these products. Polyurethanes are the modern equivalent of varnishes and shellacs. You can purchase polyurethanes in water-based formulas, but they won't produce an identical appearance. Varnishes and shellacs yellow over time, while polyurethanes remain clear.

Modern wood preservatives and water-repellent coatings aren't appropriate for treating the wood in a historic log cabin. People sometimes treated the logs or wood roofing of historic cabins with a combination of paraffin wax, plant-based oil, and solvent to help protect the wood. The oil protects the wood and the paraffin wax repels water. The FPL developed an effective formula of this historic log treatment during the 1970s that you may use to recoat cabin logs. Although this formula is the most effective treatment for logs that aren't painted or stained, it has a strong smell and is sticky and extremely flammable. Table 3 shows the formula for the FPL log oil.

Table 3—Formula for Making FPL Water-Repellent Log Oil Mix.

Ingredients	For 1 gallon	For 5 gallons
Boiled linseed oil	½ gallon	2½ gallons
Paraffin wax	1 ounce	4–5 ounces
Solvent (mineral spirits or turpentine)	Add to make 1 gallon	Add to make 5 gallons

To make the mix, start by grating the paraffin with a cheese grater. Ensure that the solvent is at room temperature. Slowly stir the grated paraffin into the solvent, mixing vigorously to dissolve the wax. Add the linseed oil, again stirring until the consistency is uniform. Then, add the solvent and stir to mix thoroughly. Some log buildings had a shiny, clear finish you can duplicate by using spar varnish instead of the solvent in the FPL log oil formula.

If possible, mix only as much FPL log oil as you can use in a day to avoid having to store this very flammable mixture. If you must store the FPL log oil at low or freezing temperatures, the ingredients may separate. You can reheat the formula to room temperature and stir it to a uniform mixture once again.

When you apply FPL log oil, wear appropriate PPE that prevents skin and eye contact; the solvents are toxic.

Start by applying a light coat of FPL log oil with a pump sprayer or brush. Apply the FPL log oil the full length of each log in a continuous application. If you stop in the middle of a log and come back later, you will create a visible line where the two applications meet, as occurs with most paints and stains. Unlike with paints and stains, the FPL log oil line fades as the log returns to its normal color. If the FPL log oil doesn't absorb evenly right away, use a brush to spread the coating evenly over the surface to prevent a splotchy appearance. Recoat until the log no longer absorbs the formula, but don't apply so much that oil icicles form on the undersides of the logs or eaves.

Avoid applying FPL log oil to daubing; it eventually will turn the daubing yellow. Don't panic if you accidentally get a little on the daubing, though; the daubing will absorb a single light coat or overspray of the formula, and the formula usually won't change the daubing's appearance. Also, avoid applying the formula to metal objects, such as vehicles, or glass, especially windows and windshields. Removing FPL log oil from those surfaces is difficult. Use sprayers only on a calm day, because any breeze will transport the formula to unintended surfaces.

If you use a pump sprayer to apply FPL log oil, use a disposable one; the sprayer will gum up within a day and you will have to discard it. If you use brushes to apply FPL log oil, use inexpensive ones and discard them whenever they get too sticky.

Properly discard all brushes, containers, pumps, and rags that you use to apply or clean up FPL log oil mix. Rags soaked with FPL log oil mix can spontaneously combust because the oil releases heat as it oxidizes. Either lay the rags flat in a single layer until they cure (become dry and hard) and then throw them in the trash, or store them in an airtight metal container until you can remove them from the site and dispose of them or have them commercially cleaned.

Do not apply paint or other commercially available decorative or protective coatings to roof materials that historically were unpainted and uncoated. Untreated wood shakes or shingles age to a silver-grey or soft brown, depending on the wood species.

Aside from damaging the historic integrity of the cabin, topcoatings on wood shingles or shakes may also lead to shortened roofing life. This occurs because the uncoated underside of the shake or shingle expands when wet and contracts when it dries, while the coated side of the shake or shingle doesn't. This differential movement eventually warps the shake or shingle, preventing it from lying flat and allowing water to leak through the roof.

You can apply FPL log oil to wood shingles and shakes on historic cabins. The FPL log oil darkens the wood for a while, but it eventually fades back to the original color. You also can apply protective coatings to wood shingles or shakes when building codes require fire-resistive treatments.

On the other hand, if someone treated, coated, or colored the original materials, make sure to treat, coat, or color the replacement roofing to visually match. Commonly used paint and stain colors changed over time because popular tastes changed and because the available pigments, carriers, binders, fillers, and additives also changed over time. Common 18th-century coatings for wood shingles or shakes included a pine pitch coating similar to turpentine and a colored, boiled linseed oil or fish oil mixture. Coloring agents for the oil mixture included oxides, red lead, brick dust, and other minerals. The coloring agents produced tints such as yellow, red, brown, and grey. In the 19th century, people applied red, chocolate brown, or brown-green stains or paints to some roofs to complement the building colors. The Forest Service stained the roofs on many compounds green during the 20th century. See Appendix F—Acquiring Tools and Materials, for a source of "Forest Service green" shingle stain.

If someone originally stained (figure 296) or coated a cabin roof, you can produce a similar look on the new shingles using semitransparent latex stain in a matching color. For best results, stain all four surfaces of well-cured, dry shingles or shakes. The full stain coverage helps prevent warping or cupping of the shingles or shakes because of differential drying and wetting. You can stain the shingles or shakes more quickly by dipping them instead of using a brush or rag, but try the process on a couple of the shingles or shakes first to ensure that it produces the desired appearance. Let the stain dry completely before installing the shingles or shakes on the roof.

Although the results won't be as good, you can apply the stain after you put the shingles or shakes on the roof if you don't have time to prestain the shingles or shakes. Use a sprayer to apply the stain and finish with a paintbrush. The price you pay for saving time is the service life of the roof. Applying stain after installing the shingles results in warping and cupping, so the shingles won't last as long as they would if you stained them on all four sides. Shakes are thicker, so they will warp and cup, but not as much as shingles. This price rarely is worth the time savings.

Figure 296—The roof of the 1934 Stump Creek Guard Station fly shed (Caribou-Targhee National Forest, Intermountain Region) still shows the original green roof stain and white trim. A Forest Service crew used logs salvaged from the 1909 Stump Creek Ranger Station buildings to build the shed.

Repairing Openings

The openings that penetrate a building's walls and roof are as important as the walls and roof themselves. Without the openings, a building would be as dark and stuffy as a rabbit hole. Doors admit people and windows bring light and air into the interior. Chimneys and flues allow smoke from a heating or cooking fire to escape the building. If not properly constructed and maintained, these openings can admit moisture that leads to the deterioration of the building. Flues and chimneys that don't function properly can lead to fires that destroy the building. Ensuring that these openings operate as intended is as important as replacing rotten logs or a roof that leaks.

Windows

The original windows in most historic log cabins are true divided lite windows (figure 297). Divided lite windows are comprised of several small panes of glass (also called lites or glazing) held by tiny wedges (also called points) and window putty (also called glazing compound) in mullions and muntins within the window frame. Individual panes of glass were historically small, because large sheets of glass were expensive before the mid-1900s and were difficult to transport to remote locations without breaking. Builders usually arranged glass panes in simple patterns of equally sized lites, but sometimes arranged them in decorative patterns, such as many small lites surrounding a larger central lite.

Nearly all original cabin windows are wood framed. In most cases, at least one-half of each window slides open either horizontally or vertically. Windows that open horizontally are simply called sliding windows. Windows that open vertically are called single hung if only one half of the window opens and double hung if each half opens. Single- and double-hung windows normally operate with the aid of pulleys, cords, and weights. Sliding windows operate on tracks within the window frame. A few log cabins have casement windows that swing open on side hinges or awning windows that swing open on hinges at the top of the window.

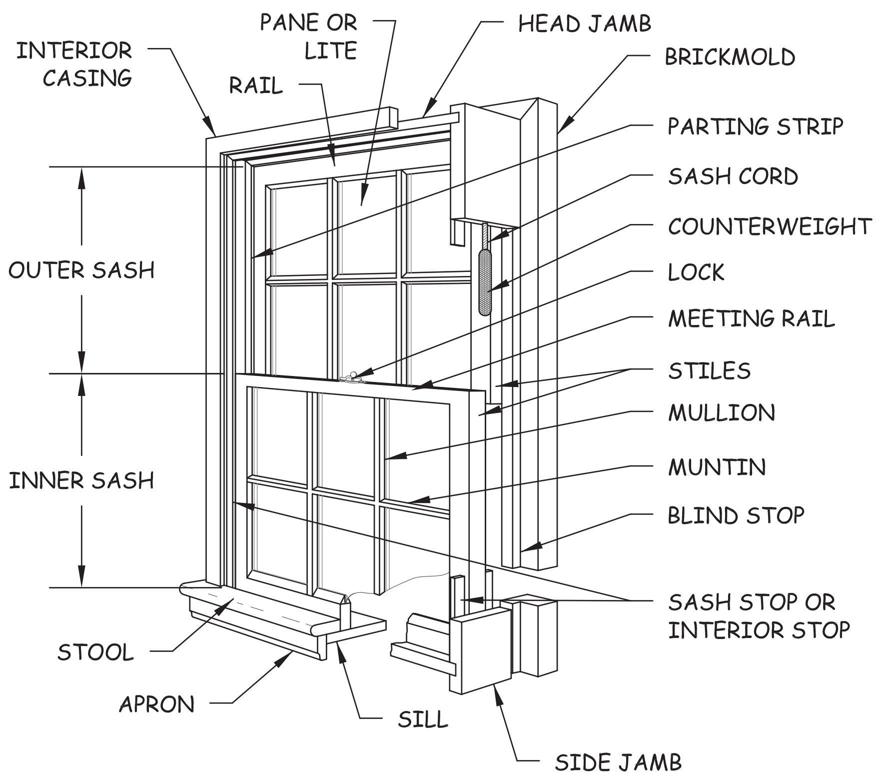


Figure 297—This drawing shows the terminology for a typical historic divided-lite, double-hung window. Although the terms "mullion" and "muntin" are sometimes used interchangeably, mullions are vertical dividers that provide structural support. Muntins are strips of wood or metal separating and holding panes of glass in a window.

Most people assume that they cannot repair wood windows (figure 298), but if you can repair a log building, you can repair a window, especially if the window was built before about 1940. The Anderson Lumber Company manufactured the first mass-produced windows in 1915, but manufactured windows were not commonly used for homes or other small buildings until after World War II. Before that time, builders usually constructed wood windows from individual parts, each of which you can repair or replace. The wood itself is likely to be denser and more rot- and warp-resistant than wood used in newer windows, so it's worth saving as much of the original window material as you can. You can patch and repair windows in much the same way as logs, only on a smaller scale.

If some of the windows in your cabin are deteriorated beyond repair, you usually should build new windows to match the size and configuration of the original windows, rather than purchasing and installing modern windows. If you can't copy the original windows because they're completely missing from the cabin, search for historic photos of the building and other buildings nearby. Replicate these styles in sizes that fit the original openings in your cabin. Do not replace historic windows with windows made from modern materials, such as fiberglass or aluminum. If the cabin windows aren't original, you sometimes can replace them with modern wood windows without adversely impacting the building.

Do not change the size of the windows unless the accessibility and fire escape requirements of applicable building codes and accessibility standards require it. Refer to the Decisions, Decisions: Deciding What To Do to the Cabin section of this guide for more information on reconciling seemingly conflicting requirements. Modifying a window affects the visual integrity of a building, so limit modifications required by code to windows that aren't on the main façade of the cabin, if possible.

Figure 298—This screened, double-hung window is on a Wyoming Game and Fish cabin at the Sunlight Basin work center. The Sunlight Basin Ranch, established in 1896, included a dude ranch component beginning in 1913. The State of Wyoming acquired the ranch in the mid-1900s.

The SHPO probably will have to approve any window changes if a Federal or State government agency owns the cabin, or if Federal or State sources provide some or all of the funding for the cabin preservation work. Check with your heritage resource specialist or archaeologist for the requirements.

Common window problems include windows that stick or don't open. Structural problems may cause windows to warp or go out of square, preventing them from operating properly. Be sure to fix any structural problems before you fix the windows, or you may have to fix the windows twice. If the window sticks, try waxing the window sash (see figure 297 for labeled window parts). If waxing doesn't work, try slightly adjusting the position of the sash stop. Tighten loose hardware and reattach loose weather stripping. You can plane down any part of the window, but keep in mind that once you plane off wood you cannot put it back.

Sash cords, counterweights, or pulleys that don't work also may prevent windows from opening. Some window frames have an access panel. Look carefully; the panel may be hidden under grime and layers of paint. If the window doesn't have an access panel, you will need to remove all the inside trim to access the moving parts. After you expose the sash cords, counterweights, and pulleys, clean everything and then make repairs. Most hardware stores sell sash cord—it may be labeled as such or as cotton clothesline.

If the window has a broken pane, remove the putty or glazing compound with scrapers, steam, or heat and replace the glass. Some older glazing compounds contain asbestos or lead, so take the necessary precautions explained in the Safety First section of this guide.

Unless the window repair is small, such as resetting a single pane of glass, you probably will need to carefully remove the window from the cabin to repair or rebuild it. Use small flat bars, pry bars, and cat's paws (figure 299). The frame and trim pieces of the windows may be sealed together with many built-up layers of paint, making them difficult to remove. Cut through the paint layers where the pieces meet using a window zipper (figure 300) or razor blade utility knife before attempting to pry the pieces apart.

If the paint on the window is deteriorated, you should remove it down to the wood before beginning repairs. Repaint it after you complete the repairs, using a color that matches the

Figure 299—These tools are handy for window work. They are, from left to right, a Woodcraft beech wood mallet and handmade window frame wedges, a smooth-head hammer, two putty knives, three small pry bars, a cat's paw, an awl, a retractable razor blade utility knife, a pocket knife and, at top right, a battery-powered drill with a long bit.

Figure 300—Use window zippers such as these to cut through layers of paint that have sealed a window frame and trim together.

original paint (figure 301). Use the methods described in the Using Paint, Stain, and Oil section of this guide to determine original paint colors and to strip paint from woodwork. This section also contains information about lead-based paint and the properties and appropriate uses of latex and oil-based paint.

Make repairs after you strip and sand the window. Repairs must match the profile (the shape, size, and joining types) of the original window components. A shaper, tenoning machine, and band saw are useful tools for matching any window profile. You can make many, but not all, profiles using multiple passes on a router, band saw, and table saw.

Carefully observing and replicating the original construction methods can help you to accomplish wood window repair. Knowing the tricks of the trade listed in the tips box on the next page makes the process easier and more effective.

Figure 301—As part of the restoration work at the Adams Camp Ranger's House on the Salmon River Ranger District (Nez Perce National Forest, Northern Region), preservation crewmembers rebuilt this kitchen window and painted it a deep green to match the original paint. This particular green was a standard color in the Northern Region when the builders originally constructed the cabin in 1933.

Tips for Effective Window Repair

- Use a linseed oil-based glazing putty that will move with the wood, such as Crawford's Natural Blend Painters Putty.
    - Do not use soya oil-based or paraffinic process oil-based putties, such as DAP 33, to glaze historic windows; these putties dry too hard and eventually will break the window.
    - Linseed oil-based putties take a few weeks to harden, so plan your work accordingly.
- Use diamond or triangular window points to hold the glass in, not modern points with "ears"—you cannot hide the ears using historic putty profiles.
- You can replace broken single-strength glass with double-strength glass or tempered glass in locations such as lookouts, where glass breakage is likely and where safety codes may require stronger glass. The change in appearance is minimal.
- You can install rubber bulb or brush weather-stripping (figure 302) to help make the windows weather tight because these are historically appropriate improvements.
- Paint carefully. Do not leave excess paint buildup or drips.
- Achieve a clean paint line at the edge of the window glass by using one of the following three methods:
    - Paint over the glazing putty and about one-sixteenth of an inch onto the glass with both the primer and paint. Although this approach sounds difficult, it is easier to accomplish if you rest your arm on the sash for stability and use a sharp-cut paintbrush. Sweep your hand down the pane in one continual motion. With a steady hand and a little practice, this method is the fastest way to get a clean paint edge.
    - Paint a little farther onto the glass, and don't worry about getting the edge straight. After the paint fully cures, use a utility knife and straight edge to cut through the paint at the edge of the putty and peel the excess paint from the glass. A safety blade scraper may be helpful to get the peel started.
    - Lay a strip of painter's tape on the glass and seal it tightly to the pane to prevent paint from leaking under the tape onto the glass. Because tape rarely seals perfectly, you probably will need to use a scraper to remove the "fuzzies" after the paint dries.

Figure 302—This mock-up of a small double-hung window shows bulb-type weather stripping on the top and brush-type weather stripping on the side. Notice how the flanges on the weather stripping fit into routed slots in the frame and hold the weather stripping in place without fasteners.

The City of San Antonio's Office of Historic Preservation website <http://www.sanantonio.gov/historic/Docs/Brochures/WindowRestorationWorkshop.pdf> has excellent information about restoring historic windows. Photos on the site show how to get an old window apart without damaging it. The site also includes reprints of documents about restoring historic windows from the National Trust for Historic Preservation, the National Park Service, and other preservation agencies.

You can use the Internet to access several historic publications intended for use by the construction trades. For instance, "Audels Carpenters and Builder's Guide, Volume 4" (1923) includes a lot of door and window information and construction techniques of the times. Source and contact information are available in Appendix G—Support Organizations and Publications Several sources for historically appropriate window hardware are listed in Appendix F—Acquiring Tools and Materials.

Storm windows are easy to build and can give your historic windows the performance of modern thermal pane windows. Look carefully for evidence that the building once had storm windows, such as clips or screws used to fasten them in place. When storm windows were present historically, matching or similar replacements are always appropriate. Interior or exterior storm windows usually are an acceptable addition where they weren't present historically if you can remove them (when not in use) without damaging the window frames. Interior storm windows should have air-tight gaskets and ventilating holes to avoid condensation damage to historic windows. More information on retrofitting historic windows to achieve energy savings is available from the National Trust for Historic Preservation <http://www.preservationnation.org/information-center/sustainable-communities/green-lab/saving-windows-saving-money/>.

Doors

People usually constructed historic log cabin doors from several pieces of wood—a frame of vertical stiles and horizontal rails holding raised or flat panels in place; a style known as “rail and stile” or “frame and panel.” They typically cut grooves into the stiles and rails and matching tongues around the edges of the panels. The tongues fit into the grooves and held the panels solidly within the frame, but allowed the panels to move a little to accommodate changes in temperature or moisture without damaging any of the door parts.

Before 1900, most frame and panel doors had vertically oriented panels in two rows separated by a center mullion stile (figure 303). Center mullion stiles became less common after 1900. Instead, horizontal panels extended the full width between outside frame stiles. The doors of cabins built after 1850 sometimes included one or more lites (window panes) instead of panels in the upper part of the door.

Figure 303—This photo shows one of the doors of the Zeigler house in Dalmatia, Pennsylvania. The site-constructed frame and panel door was built in a style that people commonly used before 1900.

Some people constructed historic log cabin doors using several vertical boards tied together by horizontal boards at the top and bottom (called “ledges” or “battens”). Many of these doors also had a diagonal board (“brace”) that extended from the top ledge to the bottom ledge and fastened to each of the vertical boards to keep the door square (figure 304). This style is known as “ledge and brace” or “plank and batten.” People usually refer to doors with tongue-and-groove vertical boards as ledge and brace style and to doors with flat-edged vertical boards as plank and batten style.

Exterior doors usually are thicker than interior doors. Modern exterior doors normally are 1¾-inches thick and interior doors usually are 1⅜-inches thick. Historic doors may be thinner or thicker. Modern doors normally are 6 feet 8 inches or 7 feet tall. Historic doors may be nearly any height that the builder found convenient. Size is one reason to repair or rebuild historic doors rather than replacing them with modern doors.

As with wooden windows, historic doors are likely to have denser and more rot- and warp-resistant wood than newer doors. It’s worth saving as much of the original material of the doors in your log cabin as possible.

The requirements for removing deteriorated paint (especially lead-based paint), replicating original profiles and finishes, stripping paint, and acquiring historically appropriate hardware and modern replacement materials are much the same for doors as for windows. For information about these subjects, see the Using Paint, Stain, and Oil and Windows sections of this guide.

Don’t repair doors until after you remove deteriorated paint (see the Windows section of this guide). Replacement parts must match the profile (the shape, size, and joining types) of the original door. Useful tools for matching original details include a shaper, tenoning machine, and band saw. You can create many, but not all, profiles using multiple passes with a router, band saw, and table saw.

Figure 304—This log cabin at Lolo Pass (Clearwater National Forest, Northern Region) has a ledge-and-brace style door. The builders constructed the cabin in 1923.

Tips for Effective Door Repair

You can successfully repair a wood door by carefully observing and replicating the original construction methods. However, the following tricks of the trade can make the process easier and more effective:

- Historically, builders usually pinned or doweled door components together, though some nailed or screwed them together. Look for evidence of wood or metal pins and dowels.
    - To disassemble the door for repairs, drill out the pins or gently tap the panels apart with a wooden mallet.
- You can use tempered glass in door windows to meet safety and building code requirements.
- You can install rubber bulb or brush weather stripping to help make the doors weather tight.
- Repaint carefully. Do not allow excess paint to build up or form drips.

Do not change the size of the doors, unless you must meet accessibility or fire safety requirements. See the Decisions, Decisions: Deciding What To Do to the Cabin section of this guide for more information on reconciling seemingly conflicting requirements. Widening a door affects the visual integrity of a building so, if possible, only modify doors that are not on the main façade of the cabin (figure 305). The SHPO will probably need to review or approve any door changes if a Federal or State government agency owns the cabin or if Federal or State sources provided some or all of the funding for the cabin preservation work. Check with your heritage resource specialist or archaeologist for the requirements.

Figure 305—As part of the renovation of the 1905 House at the Main Boulder Station (Gallatin National Forest, Northern Region), preservation crewmembers constructed a new door to meet accessibility requirements. The crew installed the door on the back of the cabin; it has the same number and configuration of panels as the historic doors, but is 36 inches wide. The crew later constructed a stoop to provide level access from the yard to the door.

Fireplaces, Wood Stoves, Chimneys, and Flues

Your cabin probably has either a fireplace with a masonry chimney or a wood stove that connects to a masonry chimney or a metal flue. The wood stove or fireplace probably provided the only source of heat and may have been used for cooking when the builders originally constructed the cabin.

Wood stoves usually have a shorter life than a cabin. Replace the stove when it no longer functions properly or it poses a safety hazard. Because it's not a permanent part of the structure, you can replace an inadequate wood stove with a newer, safer, more efficient model. You don't have to match the appearance of the original stove, but, if possible, try to find a stove that's similar in size and appearance so it won't look out of place in the cabin.

Tips on Selecting a Wood Stove

- Chose a high quality and efficient stove.
    - Ensure that the stove is Underwriters Laboratories-listed—the stove should have a tag attached.
    - Ensure that the stove is Environmental Protection Agency certified <http://www2.epa.gov/compliance/list-epa-certified-wood-stoves>
- If possible, choose a model with classic detailing that appears similar to something that might have been original to a historic cabin. While the Forest Service does not endorse or recommend specific products, some manufacturers produce stoves that have a historic look. Examples include:
    - Vermont Castings <http://www.vermontcastings.com/products/Stoves/Wood-Burning/>
    - Avalon <http://www.avalonfirestyles.com/product-guide.aspx>

Information about wood stove installation and operation is available from the National Agricultural Safety Database <http://www.nasdonline.org/document/1254/d001052/wood-stove-installation-and-operation.html> and the University of Missouri extension office <http://www.extension.missouri.edu/publications/DisplayPub.aspx?P=g1730>. Follow the manufacturer's instructions to install the new stove; do not install the stove closer to combustible surfaces than specified by the manufacturer. You may be able to reduce the clearance by using a heat shield.

A heat shield is a sheet of nonflammable material that you install on spacers to encourage a convection flow of air that prevents most of the heat from reaching the combustible material behind the shield. See the University of Delaware Cooperative Extension document "Wood Stove Installation and Operation" <http://nasdonline.org/1248/d001052/wood-stove-installation-and-operation.html> for general information about wood stove installation and heat shields.

National Fire Protection Association (NFPA) publication NFPA 211: Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances <http://www.nfpa.org/codes-and-standards/document-information-pages?mode=code&code=211>, contains the code requirements for proper spacing between wood stoves and combustibles, chimney or flue clearances and heights, and the use of heat shields. You must create a username and password before you can view this document.

The chimney or flue funnels exhaust from the wood stove or fireplace to the outdoors, taking advantage of the natural tendency of hot gasses to rise. If the flue or chimney cracks or breaks, or debris or creosote buildup blocks the flue or chimney, it becomes a safety hazard. Inspecting a flue or chimney annually and cleaning it regularly are very important. See the Fireplace, Wood Stove, Chimney, and Flue Maintenance section of this guide for more information.

If the cabin has a single-wall metal flue extending through the wall or roof of the cabin (figure 306), do not operate the wood stove until you can replace the flue with a properly constructed masonry chimney or a modern, Underwriters

Laboratories-listed metal flue that meets fire code requirements. This upgrade will affect the appearance of the cabin, but nearly all SHPOs would rather see a modern flue than a cabin that burns down because of an inadequate flue.

If you have to replace the flue, be sure to include an ash cleanout at the bottom of the vertical flue run so that you can easily remove the ash and creosote that you detach when you clean the flue with a brush. Install a spark arrester at the top of the flue unless your cabin is in a rain forest and the roof is likely to be wet when you use the stove.

Follow the manufacturer's clearance, flashing, and assembly instructions if you install a new metal flue. Do not install the flue closer to combustible materials than allowed in the manufacturer's instructions. You may be able to reduce the required clearance by installing a heat shield between the flue and the flammable materials. Check with the manufacturer and your city or county building department for specific requirements.

Remember that, to draw properly and to comply with Life Safety and International Building Codes, the top of any flue or chimney must be at least 3 feet higher than the roof adjacent to the chimney or flue **and** at least 2 feet higher than any part of the building (including the roof) that is within 10 feet of the flue or chimney. The SHPO probably will need to review or approve any change to the flue or chimney (figure 307) if a Federal or State government agency owns the cabin, or if Federal or State sources provide some or all of the funding for the cabin preservation work. Check with your heritage resource specialist or archaeologist for the requirements.

If your cabin has a masonry chimney (figure 308), keep it in good repair so that your cabin doesn't burn down instead of heating up. Fix any problems identified during the annual inspection immediately so they don't become critical hazards.

If the chimney liner is cracked, rebuild it or resleeve it with a modern, poured-in-place cement liner or a metal chimney liner. Most people lined log cabin chimneys either with high temperature clay tile pipe sections or they parged the inside of the chimney with mortar to create a smooth surface. Some people built chimneys with no liner at all. Keeping unlined chimneys free of creosote is nearly impossible, so add a liner, if you can.

Figure 306—The Bull Prairie Ranger Station on the Heppner District (Umatilla National Forest, Pacific Northwest Region) had a single-wall metal flue. Smoke drifts from the flue, which is just barely visible beyond the peak of the roof, in this photo from 1931.

Figure 307—The original brick chimney at the Adams Ranger's House (Salmon River Ranger District, Nez Perce National Forest, Northern Region) had deteriorated so badly that preservation crewmembers had to completely rebuild it. Although the crew replaced the portion of the chimney inside the building (hidden inside the interior walls) with a lined concrete block chimney, they rebuilt the portion visible above the roof to the original proportions using the original bricks.

Figure 308—The Wolf House in Norfolk, AR, built in 1829, has masonry fireplaces and chimneys on each end. The builders constructed the original chimneys of local stone. Someone apparently reconstructed the top of the chimney on the left side of the building with brick at some point after 1960; a photo from 1960 shows the chimney completely constructed of stone.

Resleeving reduces the interior diameter of the chimney. This may be good if the original chimney had a large interior diameter built for burning coal and you are now burning wood, which requires a smaller flue size. If you have a wood stove, size the chimney's interior cross-sectional area according to the wood stove manufacturer's recommendations. If you have a fireplace, make the chimney's interior cross-sectional area one-eighth the size of the total area of the fireplace opening. You won't be able to reline the chimney if you cannot reduce its interior area. You probably will have to rebuild the chimney.

Clay pipe chimney liners expand a little when they get hot. The liner must be able to move independently of the rest of the chimney, which doesn't heat up or expand as fast. If the liner is mortared directly to the chimney, it cannot expand; it will crack or shatter when you burn a hot fire in the stove during really cold weather or if a chimney fire occurs. More information on chimney liners is available from the Old House Journal <http://www.oldhousejournal.com/chimney_liners/magazine/1465>.

If you rebuild the chimney, use a layer of 30-pound asphalt felt roofing paper between the liner and chimney to create an air space. To accomplish this, roll out the felt on a relatively flat surface and cut it to the length of the liner. If the chimney is large, you may need two lengths of felt to completely cover the outside of the liner. Place one end of the felt between the lowest section of liner and the bottom of the chimney. Assemble the chimney around the felt-covered liner. Working around the floppy length of felt may be a little awkward, but it is far easier than cleaning excess mortar from the narrow, deep gap. After you complete the chimney and the mortar sets, pull out the felt. There will be a small air gap between the liner and the chimney where you removed the felt.

Over time, mortar often cracks and falls out from between the bricks in fireplaces and chimneys. Repair any mortar as soon as you discover that it's cracked. First, rake out all the cracked mortar. Raking out means removing the mortar to a ¾ inch depth from the face of the bricks (see figure 242). Use a hammer and stone chisel, rock hammer, double jack, or similar tools (see figure 243). Do not break any of the masonry or you will have to replace it and possibly rebuild the chimney. Repoint the joints that you raked out, matching the original joint profile. Match the color and type of mortar using a process similar to that used to match masonry daubing, as explained in the Chinking and Daubing section of this guide.

Crowns on chimneys may crack because of sudden heat from a flue fire, freezing and thawing moisture in the crown, or settling. Crowns built in place using mortar don't stand up to the weather as well as concrete or tile crowns; you need to rebuild them every few years. If you have a damaged mortar crown, do not patch it; remove it completely. Lay a new mortar crown with a sufficient slope to direct moisture away from the edges of the chimney.

A concrete or tile crown is relatively easy to replace, though it may be hard to find a replacement crown that matches the historic crown. You may have to cast a replacement concrete crown to replicate the profile of the historic crown. Finding a matching tile crown can be a challenge, and you may have to settle for something that isn't identical.

To replace a concrete or tile crown, first remove the damaged crown carefully to avoid damaging the flue liner or the chimney bricks. Removing a crown using pry bars usually is fairly easy because the mortar under the crown often is a little crumbly if the crown is damaged. If the crown is securely fastened, you may need to use a concrete saw to detach it. When you've removed the damaged crown, clean the top of the chimney and the side of the flue, then set the new crown in a bed of mortar.

If the fire box or the portion of the chimney directly surrounding the liner contains cracked or damaged bricks, use firebricks to replace the damaged bricks or to rebuild the damaged section. Unless surface materials hide the firebricks, use new or salvaged bricks that match the color and size of the original bricks. Use refractory mortar to set bricks in the firebox and to set sections of a clay tile flue liner. If decorative masonry covers the original chimney, reface the exterior as needed with river cobbles, split stone, or other nonflammable material that matches the original facing.

Repairing Interiors

Cabin interiors normally are fairly plain and practical and often are well crafted. A restored cabin interior can be a pleasant place to work or live. Although it would be great to restore every cabin interior to its original configuration, historic preservation standards recognize that you may sometimes need to modify interiors to serve modern purposes. For example, people often add indoor plumbing to historic cabins, which means that they must divide a bathroom from the living or working space inside the cabin. The SHPO nearly always allows such changes. The SHPO probably will need to review or approve any change to the interior if a Federal or State government agency owns the cabin, or if Federal or State sources provide some or all of the funding for the cabin preservation work. Check with your heritage resource specialist or archaeologist for the requirements.

You can determine original paint colors by using the methods described in the Using Paint, Stain, and Oil section of this guide. The section contains information about lead-based paint, stripping paint, and latex versus oil-based paint. See the Windows section of this guide for information about historically appropriate hardware, removing deteriorated paint from woodwork before you make repairs, replicating original finishes, and using modern replacement materials. The issues and solutions for interiors are the same as for windows.

Floors

Most log cabins originally had wood floors, although some builders originally constructed early 20th-century cabins with resilient flooring in service areas, such as bathrooms and kitchens. More information about resilient flooring is available to Forest Service and Bureau of Land Management employees in "Early 20th-Century Building Materials: Resilient Flooring" at <http://fsweb.mtdc.wo.fs.fed.us/php/library_card.php?p_num=0773 2322>.

Some wood flooring was plain sawn or split planks, but builders sometimes laid carefully finished tongue-and-groove flooring boards on shiplap subfloors. Many builders used wide hardwood or clear softwood boards for cabin floors. Such materials that were common when builders constructed the cabins may be difficult to find these days.

Wood floors are extremely durable if you care for them properly. If the floor in your cabin is basically sound but needs a few repairs or refinishing, the first thing to do is to sand or strip the existing finish from the entire floor (figure 309). If any individual boards have deteriorated or been damaged beyond what you can sand out or patch, replace the damaged boards using boards that match the original species of wood and board size. Finally, refinish the floor using three or four coats of water-based polyurethane or durable paint to produce a finish similar to the original (figure 310).

If the entire floor is deteriorated or damaged beyond repair (figure 311), use replacement flooring material that matches the original flooring (figure 312) as closely as possible. You may be able to salvage flooring from another building or find modern flooring that is similar.

Figure 309—Preservation crewmembers patched, planed, and sanded the kitchen floor at the Adams Ranger's House (Salmon River Ranger District, Nez Perce National Forest, Northern Region) before refinishing it.

Figure 310—The refinished kitchen floor of the Adams Ranger's House shows evidence of past heat damage from a wood stove that someone didn't properly shield. Because it shows no evidence of heat damage, it's easy to tell that someone previously replaced a short floorboard where the stove once sat.

Figure 311—The flooring inside the Square Mountain Lookout (Salmon River Ranger District, Nez Perce National Forest, Northern Region) was deteriorated beyond repair and preservation crewmembers had to completely remove it.

Figure 312—After the Northern Region Historic Preservation Team repaired or replaced deteriorated logs, floor joists, and subflooring at the Square Mountain Lookout, they installed new flooring of the same type as the original.

Before you install the new flooring, measure (at floor level) the length of the two walls that run perpendicular to the long dimension of the flooring. If the room is like most cabins, it probably is not square. If one wall is just a little longer than the other, adjust the spacing of the flooring (much like adjusting the shingles on a roof) so that the finished product looks square and fits neatly in the room. To adjust the space between the boards, place thin putty knives vertically between the boards and use them to move the boards slightly apart as necessary before fastening the boards in place. You may have to cut the last board at a slight angle to fit properly. Finish the new flooring to replicate the appearance of the original flooring.

You can install tongue-and-groove flooring most efficiently by using a flooring nailer and flooring nails, exactly like modern tongue-and-groove flooring. Install plank flooring using fastener spacing and types that match the original fastening method.

You can renovate stairs in much the same way that you renovate floors. If the stairs are well used, the treads probably have dips where they have worn down over the years. Unless the treads are broken or are worn to less than ¾ inch thick, you don't need to replace them. Wear patterns add character to the stairway. Finish the repaired stairs to match the original finish (figure 313).

Because porch floors tend to receive a lot of abuse from boots and weather, the porch floor on your cabin may be severely buckled or deteriorated and you may need to repair or replace it. Porch flooring boards swell and shrink with the weather, so you should provide a little space between them to allow them to expand without buckling and heaving. Providing space between the boards also prevents decay-causing moisture from being trapped between them. If the porch boards are plain planks, you easily can leave ⅛ to ¼ inch of space between them.

If the porch has tongue-and-groove flooring, you may find that it's a little tricky balancing the need to have the tongues set firmly into the grooves with the need to leave expansion space between the boards. The most effective strategy is to use spacers. Lay the first row of flooring and nail it down. Place the second row of flooring, but don't nail it down immediately. Insert a series of thin metal spacers or several putty knife blades between the two rows of flooring to produce a uniform space between the rows. Do not push the spacers or blades all the way to the subfloor or joists; insert them only to the tongue to create a small 1⁄64- to 1⁄32-inch gap between the two rows, then nail the flooring down. Remove the spacers or blades and repeat the process for the rest of the flooring. Finally, finish the porch to match the original finish.

Figure 313—Preservation crewmembers painted the repaired stairs in the Adams Ranger's House glossy gray to match the original finish.

Interior Walls

Occupants may have moved, added, or removed interior walls in historic cabins as their needs changed. The condition and historic assessment includes information about the original location of interior walls. Consider restoring the original wall configuration and finish if these don't conflict with the intended use of the cabin.

Interior cabin walls may originally have been round or hewn logs (figure 314). Sometimes, people framed interior walls with lumber and then plastered the walls. People also covered walls with early versions of gypsum wall board, paneled them with tongue-and-groove (figure 315) or plain boards, covered them with fiberboard (sometimes called Beaver Board) (figure 316) or plywood, or covered them with any combination of these finish materials.

Figure 314—The builders hewed and rough sanded the insides of the log perimeter walls at the kitchen and bathroom of the Adams Ranger's House to form a relatively flat surface. The builders originally covered the logs with fiberboard, but the fiberboard was severely deteriorated and the preservation crew did not replace it in the kitchen or bathroom when they repaired the cabin.

Figure 315—The builders originally paneled the parlor walls of the Adams Ranger's House with tongue-and-groove boards. Preservation crewmembers repaired and retained the paneling when they renovated the cabin.

Figure 316—Preservation crewmembers repaired the original fiberboard panels and wood battens covering the upstairs walls of the Adams Ranger's House when they could save them and replaced the panels and battens when they couldn't.

You should repair cabin walls in kind to match the original wall surfacing (figures 317, 318, and 319). If you must build new walls to accommodate the current use of the cabin, the new walls should be similar in appearance to the original walls in that part of the cabin.

The builders originally covered the interior walls of some cabins with painted paneling or fiberboard. Fiberboard sometimes is called by the manufacturer's name, such as Upson Board, Beaver Board, Homasote board, and Celotex. Several manufacturers still produce this type of wallboard. Fiberboard crumbles when it gets wet. There's no way to patch the crumbled fiberboard, so you must replace it. More information about repairing and replacing fiberboard is available to Forest Service and Bureau of Land Management employees in "Early 20th-Century Building Materials: Fiberboard and Plywood" at <http://fsweb.mtdc.wo.fs.fed.us/php/library_card.php?p_num=0773 2308>.

Figure 317—The original fiberboard covering the walls in the upstairs west bedroom at the Adams Ranger's House was damaged by water leaking through the roof, rodents, and vandalism.

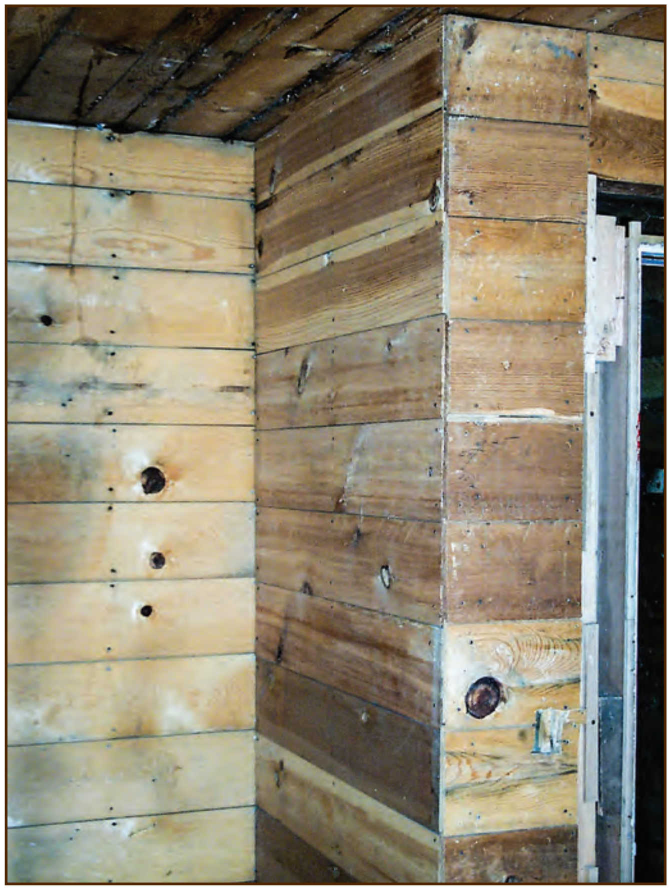


Figure 318—When the preservation crew removed the damaged fiberboard panels in the west bedroom, they found that all of the interior walls and the ceiling were covered with ¼-inch-thick boards to provide solid backing for the fiberboard panels.

Figure 319—The preservation crew replaced damaged sections of fiberboard in the west bedroom with similar modern fiberboard panels, reinstalled the original wood battens to cover the panel joints, and replaced or reinstalled the trim boards. The crew painted the panels, battens, and trim boards to match the original colors.

Paint interior walls and trim to match the historic paint colors, even if the historic colors aren't considered attractive or appropriate by current standards. Determine the original paint colors using methods described in the Using Paint, Stain, and Oil section of this guide. A cheerful comment about "ugly" paint colors: at some point during the preservation project, someone usually will complain about the ugly historic paint colors. When you paint the trim, walls, and floor with the historic colors, put the appropriate furniture in place, and hang curtains in the windows, the historic colors (figure 320) will look pretty good.

Figure 320—The 1890 Morgan-Case homestead cabin (Missoula Ranger District, Lolo National Forest, Northern Region) is listed on The National Register of Historic Places. "Passport in Time" volunteers refurbished the cabin, including repainting the interior using historic gray and cream colors. The cabin is available to rent for recreational use.

Propane, Plumbing, and Wiring

Most people who can repair cabin logs are able to follow manufacturer's instructions for making minor plumbing or electrical repairs, such as replacing a faucet or light fixture. If the condition assessment for your cabin identified serious plumbing or wiring problems, hire a licensed plumber or electrician to fix them. Licensed professionals operate safely and properly and perform work that meets code requirements. While the licensed professional is onsite, consider having him or her check all the wiring or plumbing for other problems that the condition assessment might have missed.

Some log cabins built in the 20th century used propane to power light fixtures, cook stoves, and even refrigerators. Historic propane piping is unlikely to meet current code requirements. For instance, most building codes no longer allow hard copper supply piping. Have hard copper piping replaced with soft copper, black iron, or stainless steel, as required by the local code. In addition, shutoff valves, which people seldom used on historic piping, now are required near each appliance. If the condition assessment identified any problems with the piping, hire a licensed propane gas professional to thoroughly assess the piping and connections and to perform any necessary repairs or replacements.

Regardless of who does the work, it is important to install historically appropriate fixtures, operating mechanisms, and hardware. If the original items still are in place (figure 321) or photos show the appearance of the original items, use replacements that look similar. If no evidence of the original items exists, use replacements that are appropriate for the time period and location (figure 322). For instance, Mission-style, craftsman-type light fixtures might be appropriate for a 1926 cabin in California, but would most likely not be appropriate for a 1908 cabin in Minnesota. Appendix F—Acquiring Tools and Materials, lists some sources for historically appropriate plumbing and lighting fixtures.

Appliances, on the other hand, don't necessarily require a historic appearance because they aren't permanently attached to the building. If you want to have a consistent historic look throughout the interior, purchase modern appliances that are manufactured with a retro or historic appearance, or old appliances that are retrofitted by appliance dealers to bring them up to current code. Preservation trade magazines, such as Old House Journal, carry advertisements from many of these manufacturers. Appendix F—Acquiring Tools and Materials, lists some sources for these historic or historic-appearing appliances.

Figure 321—This toilet is original to the 1938 Cookhouse at Fenn Ranger Station (Nez Perce National Forest, Northern Region). The toilet still works just fine, although it is not water efficient.

Figure 322—This propane light fixture is not original to the kitchen of the 1933 Ranger's House at the Adams Camp Work Center (Nez Perce National Forest, Northern Region), but it is similar to fixtures available locally when the builders constructed the cabin.

Log Cabin Maintenance

Every building has an optimum maintenance cycle. Proper maintenance keeps your building in excellent condition. Although you'll seldom have enough money, time, or labor for proper building maintenance, you can either find them or pay later for repairs that are much more expensive. It can be a vicious cycle.

Surprisingly, the easiest components to maintain on a log cabin are the logs. They are massive and sturdy. If they stay reasonably clean and dry, logs will provide decades (sometimes centuries) of service. Maintain the rest of the building much as you would your home, paying special attention to materials that don't last long, such as daubing. Unlike your home, most repairs and replacements must match the historic materials.

The Forest Service requires regular inspections (called condition surveys) and maintenance of all buildings under its care. Forest Service employees can refer to the report "So That's Why It's Always Cold in Here: A Guide for Conducting Facilities Condition Assessment Surveys" <http://fsweb.mtdc.wo.fs.fed.us/php/library_card.php?p_num=0473 2839> for guidance on performing a condition survey. Condition surveys are not the same as condition assessments, which the Forest Service requires every 5 years for reporting deferred maintenance needs on Forest Service buildings. Condition assessments aren't as detailed as condition surveys. Forest Service employees can find information on performing condition assessments at <http://fsweb.wo.fs.fed.us/eng/programs/facilities/assess.htm>.

You can keep your log cabin in good shape if you regularly perform the following maintenance items:

- Exterior and structure maintenance
- Log protection
- Fireplace, wood stove, chimney, and flue maintenance
- Roof maintenance
- Interior maintenance

Exterior and Structure Maintenance

Quarterly or semiannually, remove accumulated pine needles, leaves, and other debris from roofs, gutters, and the base of the building. Remove debris from the log walls. Prune nearby trees, shrubbery, and grass away from the building logs.

Inspect the building's entire exterior and structure annually. Inspect the slope of the ground around the building to ensure proper drainage and ensure that water still drains away from the building. Examine the structure and surface of the logs, roof, and foundation; repair as needed, paying particular attention to:

- Daubing
- Crown ends
- Purlin ends
- Rafter tails
- Weather damage

Log Protection

Every few years, reapply FPL log oil to logs that aren't painted or stained, and to cedar shingle or shake roofs. As wood dries out, it shrinks and cracks. FPL log oil restores the wood and repels water. Be especially thorough when recoating sill and spandrel logs and rafter tails; these logs tend to take more punishment from the weather and deteriorate more rapidly if not properly cared for. FPL log oil is the standard treatment for logs. The Using Paint, Stain, and Oil section of this guide contains a recipe and application information for this mixture.

You can purchase many commercial log protectants, but most aren't appropriate for historic buildings. They don't penetrate into the logs, so they only protect the surface. These products also build up on logs, preventing moisture from evaporating. Even though the FPL log oil mix has a strong smell and is sticky, it fully penetrates the logs and leaves them dry to the touch. The smell dissipates in a few days.

Fireplace, Wood Stove, Chimney, and Flue Maintenance

If your fireplace or wood stove isn't operating properly, immediately put out the fire and inspect the fireplace or wood stove and the flue or chimney to find the source of the problem. Wood stoves and fireplaces that operate properly have the following characteristics:

- Fires light easily and burn bright and hot.
- Smoke immediately rises up the flue or chimney when you light fires.
- Draft builds quickly.
- Smoke continues to rise up the flue or chimney when you open the stove door or fireplace screen.
- When no fire is burning, but it's warmer inside the cabin than outside, air flows into the stove or fireplace rather than from the fireplace or stove into the room.

Clean the ashes out of wood stoves as needed to allow proper combustion, or at least once a week. Dispose of or store ashes outside in a noncombustible container with a tight lid.

Each spring and fall, or more often if you frequently bank fires, inspect the fireplace or wood stove and flue or chimney. Check the following, and correct or repair problems as needed:

- The area around the chimney or flue should be free of bird nests, tree branches, and other debris.
- The fire grate should be clean and intact—replace it if it is cracked or distorted.
- The firebricks and mortar should be intact—replace any that are damaged or cracked.
- The ash pan should be clean and in good shape—replace ash pans that develop holes.
- The fire rope seals around the doors and glass of the stove shouldn't be frayed or compressed and shouldn't have gaps. Close the door over a thin piece of paper; it should be difficult to pull the paper out again. Replace frayed or missing fire rope.
- The seals between the side and top plates of cast iron stoves should be intact. Reseal with fire cement if you find gaps.
- The finish on the stove should not be flaking or rusting. Remove a deteriorated finish using a wire brush or steel wool and touch it up with heat-resistant paint or black grate polish to match the original finish.
- The stove door or fireplace screen glass should be clean and have no cracks. Clean the glass using commercial glass cleaner and replace any cracked glass.
- Components, such as dampers, hinges, chimney caps, and spark screens, should not be loose, cracked, rusted, or damaged. Repair as necessary.

Use flue brushes to clean the flue or chimney whenever any significant amount of creosote builds up. Do not burn out the flue because the intense heat can damage the flue or chimney or even spread the fire to the rest of the cabin and damage or destroy it. Remember that most of the creosote buildup will likely be near the top of the flue or chimney and won't be visible from inside the building, even if you pull the flue pipe and look inside.

Hire only chimney sweeps certified by the Chimney Safety Institute of America or a State chimney sweep's guild. Hiring a certified chimney sweep to inspect all flues and chimneys once a year usually is sufficient, but don't ignore the flue for the rest of the year. You can rely on trained Forest Service personnel to clean the flues and chimneys at other times when the chimney needs it, and to perform the other semiannual inspection.

Roof Maintenance

Inspect your cabin's roof at least once a year, preferably right after you clean it, for signs of deteriorated roof materials. Repair any roofing problems immediately.

See the Safety First and Keeping the Rain Out sections of this guide for tips on working safely on roofs. Be sure to follow OSHA requirements (including fall protection), the Forest Service Safety Code Handbook (6709.11, chapter 33), and the procedures in your JHA.

Clean the roof whenever you notice debris. Even if the roof is metal, debris or dirt can accumulate and provide a good environment for moss, lichens, and fungi to grow. Clean the roof at least once each year in damp climates and where trees overhang the roof. A roof in drier climates generally can go much longer between cleanings, unless a lot of dust regularly settles out of the air.

You have to get up on a roof to clean it. Use a broom or a hose, or maybe both. Starting at the ridgeline, sweep or hose the debris down and off the roof. **Never** stand on the ground with a pressure hose and try to blow dirt, debris, or moss off the roof. The water and debris will blow under the roofing. It may cause the roof to leak immediately and probably will cause future leaks and decay in the structure.

Most roofs don't benefit from foot traffic. In fact, you shouldn't walk on some roof materials at all, including slate tiles and clay tiles. If your roof won't hold up under foot traffic, hang a self-supporting ladder over the ridge of the roof or use planks to span the roof surface when you need to access it. Walk carefully on all other roofs. Do not step on standing seams or other attachment areas. Walk on the roof only when you absolutely have to. Be careful to not drop tools and equipment that could damage the roofing.

Clean gutters in the fall and again in the spring if any trees are in the immediate area. Keep gutters and downspouts clear of debris so water flows away from the building rather than seeping beneath the roofing at the eaves. Clean rainwater systems help prevent leaks, material deterioration, and wet basements. If your gutters or downspouts clog frequently, consider installing hidden gutter screening at downspouts or across the full length of the gutter to help keep debris out.

Do not allow moss to grow on your roof. Moss grows on any roof material if the roof retains enough dust and moisture for extended periods, especially if trees shade the roof. Moss is a persistent problem on roofs in some climates. It looks picturesque, but it damages both wood and composition shingles, creates gaps that lead to leaks on slate and clay tile roofs, and reduces water drainage from metal roofing, causing leaks at the seams. See the Oregon State University web page "Mosses on Rooftops" <http://bryophytes.science.oregonstate.edu/page9.htm> for general information on this subject.

Red cedar has a natural fungicide that resists the growth of moss, lichens, and fungi, unless you use the shingles in unusually warm, moist environments, or where certain strains of spores are found. See the Oregon State University publication "Care and Maintenance of Wood Shingle and Shake Roofs" <http://owic.oregonstate.edu/sites/default/files/pubs/shake_roof_maintenance.pdf> for more information about the effect of moss on wood roofs.

Sometimes, you can simply remove moss by cleaning the roof. Sometimes you need to kill the moss first. Although you can purchase a variety of chemical treatments, try the least toxic product you can find first. Only resort to more toxic products if your moss doesn't respond to the less toxic products. Oregon State University's website <http://bryophytes.science.oregonstate.edu/page24.htm> contains information about various types of chemical moss control that can help you decide on an appropriate treatment.

To reduce moss growth, keep the roof clean and remove overhanging tree branches or entire trees to allow sun and breezes to reach the roof. Remember that your cabin's original landscape did not include overhanging trees. Those trees grew after your cabin was constructed and are not good for your roof.

A zinc or copper ridge cap or a zinc or copper strip installed under and extending out about 1 inch from the bottom edge of ridge shingles will help to inhibit the growth of moss. You may sometimes need a second strip midway down the roof if it has a long slope, especially on hip ends. Copper seems to be more effective than zinc but also is more expensive.

Builders in the 19th and 20th centuries commonly installed copper or zinc strips and ridge caps (figure 323) on roofs. If the builders didn't originally install them on your cabin's roof, you may need approval from the SHPO if a Federal or State government agency owns the cabin, or if Federal or State sources provide some or all of the funding for the cabin preservation work. Check with your heritage resource specialist or archaeologist for the requirements. You can apply a zinc sulphate treatment to the roof every few years rather than installing metal strips.

The FPL has found that fungicides extend the life of shingles. You can read the FPL publication "Performance of Preservative-treated Wood Shingles and Shakes" at <http://www.fpl.fs.fed.us/products/publications/specific_pub.php?posting_id=15527>. The publication explains how these products work and which work most effectively.

Carefully follow the manufacturer's application instructions and local code requirements to properly handle and apply herbicides, fungicides, or pesticides. Check the material safety data sheet and be sure to comply with the requirements of your job hazard analysis, which includes wearing personal protective equipment such as goggles and gloves.

Once a year, remove debris, weeds, and plants with deep roots from vegetated or sod roofs. Mosses and fungi normally aren't a problem on vegetated or sod roofs. Insects will likely not be a problem either; they will attract birds that eat them. Most vegetated roofs have light soils, so you usually can remove weeds simply by pulling them out. If soil clings to the roots and leaves a hole, brush or knock the soil off the root wad and pat it back into place on the roof.

Unless absolutely necessary, do not apply any fungicides, herbicides, or pesticides to vegetated roofs. These products will disrupt the mini-ecosystem that exists on the roof. If you have to use them, use the least toxic product you can find that will do the job.

Figure 323—The zinc ridge cap on the Brush Creek Work Center Office/Visitor Center (Medicine Bow-Routt National Forest, Rocky Mountain Region) provides some protection against moss on the shingle roof.

Check your vegetated roof once or twice a year to see if you need to add dirt or sod back to the peak. Just as on a sloped hillside, sod tends to migrate from the peak downhill to the eave because of gravity. In many cases, you can simply cut the sod off the eave and move it back to the peak.

Ensure that you properly vent attic spaces to prevent condensation that can rot the roof structure. For more information on venting attics properly, see the Insulation and Ventilation section of this guide.

Historic cabins that people occupied year round weren't built to hold heavy snow loads. The cabins weren't insulated, so the heat from inside the building melted any snow on the roof. Many of these cabins no longer are used during the winter, so snow can accumulate on the roofs and damage or even collapse the roof structure. Have a structural engineer determine the maximum allowable snow load in these cases. When the roof approaches that load, remove the snow (figure 324) to keep the building intact. In some cases, you may need to strengthen the roof structure to hold more snow.

Figure 324—Forest Service employees originally used the Moose Creek Wilderness Station (Nez Perce National Forest, Northern Region), built in the early 1900s, as a year-round Ranger Station. Employees now only staff it from late spring through the autumn hunting season. When an unusually deep, heavy snowpack accumulates, employees must travel to the site on skis to remove the snow so that the roofs won't collapse. This photo shows an employee on the roof of the Office/Cookhouse building, constructed in 1921. Employees used crosscut saws to slice the snow into chunks, which they then slid off the roof. When performing this type of work, use proper fall protection.

Of course, the opposite also can happen. Some people built uninsulated or poorly insulated cabins to use only during the summer. When people use these cabins during the winter, heat escaping through the roof melts the snow, and the water runs down the roof where it refreezes at the eave overhangs and creates ice dams. Ice dams lead to leaks, water staining, and structural damage.

If ice damming is a problem at your cabin but you can't add insulation, you may need to remove the old roofing and install solid sheathing and ice and water shield, and then replace the roofing. You may need to add extra flashing or snow guards or take other measures to mitigate ice damming (figure 325). The SHPO probably will have to review or approve any changes to the building if a Federal or State government agency owns the cabin, or if Federal or State sources provide some or all of the funding for the preservation work. The SHPO usually approves beneficial changes that retain the character of the building. Check with your heritage resource specialist or archaeologist for the requirements.

Figure 325—The King's Hill Cabin (Lewis and Clark National Forest, Northern Region) had an ongoing ice problem at the back stoop because of refreezing melt water running off the uninsulated roof. The cabin now has a new back porch to shield the back stoop from ice and to also provide an accessible entrance to the building. The addition of the stylistically compatible porch ensures the cabin's continued use in the winter. The porch is clearly differentiated from the original construction by the wooden walkway and the concrete (rather than stone) column supports.

Interior Maintenance

Maintain the interior of a log cabin to keep it in good operating condition, as you would any building, paying particular attention to:

- Leaks, drips, or wet spots at or near plumbing fixtures or pipes
- Electric or gas appliances or fixtures that don't operate properly
- Doors or windows that don't close properly or don't seal weather out
- Kinks in gas lines or odors that might indicate gas leaks
- Any evidence of rodent occupation—hantavirus can be fatal. See "Controlling Rodents in Forest Service Facilities: Reports from the Field" <http://www.fs.fed.us/eng/php/library_card.php?p_num=1471%20 2309P> for information about controlling rodent occupation.

Keep floors clean to minimize surface damage from sharp-edged, tracked-in debris. Sweep up dirt regularly so that it doesn't get tracked around. Do not use a rag mop to clean the floor because it will drag dirt around and leave water residue. Instead, use a good sponge mop or a disposable wet mop or mop pad and don't let water stand on the floor. Dust all horizontal surfaces, including interior wall logs, at least once a year. Interior wall logs accumulate dirt and dust, which holds moisture in the log and leads to mold and rot.

Use Your Log Cabin

After you repair your log cabin, the best thing you can do is to use it. That may sound strange, but it really is common sense if you think about it. A building that you use will be cared for so that it can continue to serve its purpose. A building that is solely for display may not last much longer than the person who advocated restoring it in the first place. The Forest Service often uses log cabins as seasonal crew quarters or recreation rentals or for administrative purposes, such as offices, storage, visitor contact points, and so on. A building with no purpose will only sit and decay until (hopefully) somebody else takes up the preservation cause and again brings it up to serviceable standards—or until fire or weather destroys it or it simply melts into the ground.

So, use your log cabin, take good care of it, and it will be around to tell its story to the next generation.

Appendix

- Appendix A—Preservation Reasons
- Appendix B—Preservation Requirements
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Appendix A—Preservation Reasons

Why preserve log buildings? According to Pete Brown, the Historic Architecture Specialist with the Montana State Historic Preservation Office, building preservation has intrinsic appeal to civic-minded optimists, backwoods romantics, and hard-nosed pragmatists. People are motivated to preserve old buildings for cultural, aesthetic, practical, and environmental reasons. In addition, each Federal agency is required by law to carefully care for the historic sites and structures (including log cabins) that the agency owns or funds and that are eligible for or listed on the National Register of Historic Places.

Cultural reasons for preserving log cabins include:

- They are a tangible link to the past.
- They reflect the time of their creation as a counterpoint to our own (priorities, values, technology, community self-image).

Aesthetic reasons for preserving log cabins include:

- Architecture is public art.
- Retaining log cabins sustains the architectural diversity of a community.
- Retaining log cabins preserves the builder's or settler's vision.

Practical reasons for preserving log cabins include:

- Restored log cabins can contribute to community development.
- Log cabins are less material intensive (but more labor intensive) than new construction.
- Existing log cabins utilize existing infrastructure (no need for adding infrastructure, as with new buildings).
- Restoring existing log cabins builds and sustains the local tax base.
- Older buildings can be more affordable for startup businesses or first-time homeowners.
- Restoring a log cabin extends the life of the owner's previous investments.
- Tax credits may be available.

Environmental reasons for preserving log cabins include:

- Construction of historic buildings created a smaller carbon footprint than construction of modern buildings (hand work, animal power, and local producers).
- The builders usually constructed historic cabins in locations that pedestrians could access.
- The builders usually constructed historic cabins to utilize natural light and ventilation.
- "The greenest building is the one that is already built" (Carl Elefante, Fellow of the American Institute of Architects). Continuing to use log cabins means that the materials and energy used to construct them doesn't go to waste, additional materials and energy don't have to be used to replace them, and no additional agricultural or natural land must be converted to urban use.

Building preservation can achieve what investors, planners, architects, historians, environmentalists, oldtimers, and newcomers value—all at the same time. So why preserve log buildings? Because it is pretty cool to save them.

Appendix B—Preservation Requirements

Making a decision to retain or repair a historic log cabin is only the first choice of many that will lead to actual work on the cabin. First, you have to decide which "treatment" is appropriate, taking into account the building's historical significance, condition, and proposed use.

The four treatment options are preservation, rehabilitation, restoration, and reconstruction. The Secretary of the Interior has established official standards for each treatment option. The standards generally describe appropriate work for each treatment option. The Secretary of the Interior's Standards for the Treatment of Historic Properties often are referred to simply as "the standards." The standards define how to maintain, repair, and reconstruct buildings in each treatment category and how or whether to make new additions or alterations.

Preservation sustains the existing form, integrity, and materials of a historic building. Preservation of log cabins is the focus of this report.

- Identify, retain, and preserve historic materials and features.
- Stabilize deteriorated historic materials and features as a preliminary measure.
- Protect and maintain historic materials and features.
- Repair historic materials and features.
- Limit replacement in kind of extensively deteriorated portions of historic features.
- Do not obscure, damage, or destroy character-defining materials or features in the process of meeting code and energy requirements.

Rehabilitation makes a compatible use possible through repair, alterations, and additions, while preserving the parts or features of the building that convey its historical, cultural, or architectural values. This treatment option is the most liberal of the standards and the most widely applied by corporations and individuals because it retains the historic character while enabling the building to function in a way that meets modern needs.

- Identify, retain, and preserve historic materials and features.
- Protect and maintain historic materials and features.
- Repair historic materials and features.
- Replace deteriorated historic materials and features.
- Replace important historical features that are missing.
- Make additions or alterations that do not radically change, obscure, or destroy character-defining spaces, materials, features, or finishes.
- Do not radically change, obscure, damage, or destroy character-defining materials or features in the process of meeting code and energy requirements.

Restoration accurately depicts the form, features, and character of a building as it appeared during a particular period of time. During restoration, the restorers remove features from other time periods and reconstruct missing features from the restoration period. Restoration allows for some upgrading of mechanical, electrical, and plumbing systems and other code-required work.

- Identify, retain, and preserve materials and features from the restoration period.
- Protect and maintain materials and features from the restoration period.
- Repair materials and features from the restoration period.
- Replace extensively deteriorated features from the restoration period.
- Remove existing features from other historic periods.
- Recreate missing features from the restoration period.
- Do not obscure, damage, or destroy historic materials or features from the restoration period while meeting code and energy requirements.

Reconstruction means rebuilding a structure that no longer exists. The form, features, and detailing of the building during a specific time period are replicated in the building's historic location.

- Research and document historical significance.
- Investigate archeological resources.
- Identify, protect, and preserve extant historic features.
- Reconstruct nonsurviving building and site.
- Do not destroy existing historic features and materials or obscure reconstructed features while meeting code and energy requirements.

Information about the standards for each historic treatment category is available at <http://www.nps.gov/tps/standards.htm>. Federal and State agencies must follow the standards when modifying log cabins that are eligible for or listed on the National Register of Historic Places. People also must follow the standards during grant-in-aid projects assisted through the National Historic Preservation Fund or if they use Federal or State funds on buildings that are eligible for or listed on the National Register of Historic Places. Of course, the standards may be used by anyone planning and undertaking work on historic properties, even if compliance isn't required.

To explain how to accomplish the standards, the Secretary of the Interior has established guidelines for performing the work outlined in each standard. Illustrated Guidelines for the Treatment of Historic Properties, a web-based presentation of the four treatment standards, are available at <http://www.nps.gov/tps/standards/four-treatments/standguide/index.htm>. These guidelines explain in detail the appropriate methods for each treatment standard.

Choose the appropriate treatment category for your cabin based on the condition of the structure, its importance in history, and its proposed use. After you determine the appropriate treatment and familiarize those in charge of the project with the requirements, project planning and then actual preservation work can begin.

Appendix C—Preservation History

Log cabins are a small part of America's historic building inventory. Public activism is largely responsible for the continued existence of much of this valuable resource. In the late 1940s, leaders of the growing American preservation movement realized that a national organization was needed to provide support and encouragement for grassroots preservation efforts. Because of their efforts, Congress passed legislation, signed into law by President Truman in 1949, to establish the National Trust for Historic Preservation (NTHP) <http://www.preservationnation.org>. The NTHP is a private, nonprofit membership organization that provides leadership, education, advocacy, and resources supporting efforts to save America's diverse historic places and revitalize communities at the grassroots level.

Realizing that private efforts alone would not be enough to achieve preservation of a meaningful sample of historic buildings and places, Congress passed the National Historic Preservation Act (NHPA), which President Johnson signed into law in 1966. The NHPA <http://www.achp.gov/nhpa.html> provides leadership for preservation and fosters conditions that encourage private and public conservation of prehistoric and historic resources through incentives and regulations. The Act transformed the Federal Government into a preservation facilitator and a responsible steward for future generations.

To achieve this transformation, the NHPA and related legislation established a partnership between the Federal Government and the States that capitalizes on the strengths of each entity.

- The Federal Government, led by the National Park Service (NPS), provides funding assistance, basic technical knowledge and tools, and a broad national perspective on America's heritage.
- The States, through State Historic Preservation Officers (SHPOs) appointed by the Governor of each State, provide matching funds, a designated State office, and a statewide preservation program tailored to State and local needs and designed to support and promote State and local historic preservation interests and priorities.

NHPA also created an Advisory Council on Historic Preservation (ACHP), a cabinet-level group consisting of experts in the field and representatives from Federal, State, and local governments appointed by the President, to address historic preservation issues. ACHP provides private citizens and local communities a forum for influencing Federal policy, programs, and decisions concerning historic properties.

Section 106 of NHPA established the legal status of historic preservation in Federal planning, decisionmaking, and project execution. It requires all Federal agencies to take into account the effects of their actions on historic properties, and provide ACHP with a reasonable opportunity to comment on those actions and the manner in which Federal agencies take historic properties into account in their decisions.

Individual citizens, organizations, businesses, communities, elected officials, and public institutions support historic preservation in various ways. Across the country, preservation relies on a partnership among the ACHP, NPS, SHPOs, NTHP, State and local governments, and Native American tribal governments. Most parts of the country have implemented State and local laws, statutes, and regulations that are closely modeled on Federal examples. Grant funds, tax credits or rebates, and public recognition have inspired and rewarded preservation efforts.

Appendix D—Glossary

See figures 4 and 5 for illustrations of common components of log cabins and early 20th-century houses and figure 296 for an illustration of window parts. These figures may enhance your understanding of some glossary terms.

Adz—A tool, similar to an axe but having an arched blade attached at a right angle to the handle, used to shape and trim timber (see figure 97).

Band clamp—A long strip of metal material with threaded tightener that is used to hold logs together during log replacement (see figures 58, 63, and 64).

Beetle mallet—A large, heavy mallet with a wooden head, used to move a framing member or log a short distance (see figure 91). Sometimes called a persuader.

Broadaxe—A bladed, hand-held implement with a wide, flaring head and short handle, used for shaping and hewing timber (see figure 96).

Brush weather stripping—Weather stripping consisting of a strip of bristles with a winged friction mounting that is inserted into a slot cut into the wood frame of a window or door. Comes in long strips or rolls (see figure 302).

Bulb weather stripping—Weather stripping consisting of a compressible tube with a winged friction mounting that is inserted into a slot cut into the wood frame of a window or door. Comes in long strips or rolls (see figure 302).

Calipers—An instrument for measuring and transferring a precise measurement from one surface to another (see figure 89).

Cant hook—A lever tool with a hinged, hooked arm near the end, used to grip and turn a log over. Similar to a peavey, but with no spike (see figure 91).

Cant strip—A triangular board that is used at the joint between a vertical element, such as a dormer, and the drainage pitch of the roof to guide water away from the vertical surface and provide support for roofing, asphalt felt roofing paper, or ice and water shield that is bent up the vertical surface (see figure 237).

Chimney crown—The element that caps the top of the chimney and prevents intrusion of water into the masonry from the top. Crowns may be premanufactured (see figure 307) or site built (see figure 241). The flue liner (if any) extends through the chimney crown.

Chinking—Material used to fill the horizontal spaces between logs (see figures 192 and E31).

Chisel—A long-bladed handtool with a beveled cutting edge and a handle designed to be struck with a hammer. Used to cut or shape wood, stone, metal, or other materials (see figures 98 and 99).

Commander—A big mallet (see figure 91).

Commandette—A big mallet, but smaller than a commander (see figure 91).

Coping—A U- or V-shaped trough cut down the length of the underside of a log that mimics the round shape of the log below it. When coped logs are stacked, little or no air can pass between them (see figure 25).

Counterweight—A weight that balances the weight of another object. Used in single-hung or double-hung windows (sash weight) to make it easier to raise or lower a window sash, and to hold a window sash in place when it is raised or lowered (see figure 297).

Course—A horizontal row of material units, such as a horizontal row of bricks or a horizontal row of shingles or shakes.

Cribbing—Boards or lumber stacked in a crosshatch pattern to support a structure during construction work that requires removing existing structure support (see figure 73).

Crosscut saw—A saw used for cutting across the grain of a log or large timber (see figure 100).

Crown end—The end of a log that extends beyond the notching at the corner of a log building (see figure 43).

Daubing—The finish layer covering chinking or gaps between wall logs (see figure 26).

Double-hung window—A window, typically taller than wide, having two vertically stacked halves that can each be opened.

Double-strength glass—Sheet glass that is about ⅛ inch thick, as opposed to single-strength glass, which is about 1⁄16 inch thick.

Drawknife—A single-edge blade with a handle at each end, operated by drawing the knife over the surface toward the user. Used to shape wood or remove bark from a log (see figure 93).

Epoxy—An adhesive made from synthetic thermosetting polymers. Also, paint, plastics, or other materials containing these polymers (see figure 109).

Felling axe—A full-size axe for felling trees and sectioning logs—the Jersey Pattern axe in figure 95 is an example of a single-headed felling axe and the Bluegrass Western Pattern axe in figure 95 is an example of a double-headed felling axe.

Fiberboards—Construction panels made from compressed wood or other plant fibers and binders, manufactured using compression and heat. Sometimes referred to by their manufacturer's names, such as Upson Board, Beaver Board, Homasote, and Celotex (see figure 316).

Fire box—The part of a fireplace or wood stove where fuel combusts.

Flashing—

- **Base flashing—**Runs across and a short distance up the chimney where the chimney meets the roof. Sits on top of the shingle or shake course that is cut to butt into the chimney. Folds around the bottom corners of the chimney and tucks up along the sides (see figure 244).
- **Counter flashing—**Placed in the mortar joints; overlays the base, step, and saddle flashing (see figures 246 and 247).
- **Saddle flashing—**Laid at the upper side of the chimney at the saddle; overlays the step flashing (see figure 245).
- **Step flashing—**Laid with each course of shingles along the sides of the chimney; overlays the base flashing at the lower side of the chimney (see figures 244 and 244).
- **Valley flashing—**Applied in roof valleys where two roof planes intersect, producing an internal angle (see figures 253, 254, and 255).
- **Vent flashing—**Applied around vents that extend through the roof (see figures 249 through 252).

Frame and panel door—(also known as rail and stile) A frame of vertical stiles and horizontal rails holding raised or flat panels in place to form a door (see figures 303 and 305).

Frass—A sawdust-like powder produced by wood-boring insects as they drill into a log or timber, visible on the exterior of affected wood structures after the insects expel it through the bored hole.

Footing—The bottommost part of a foundation, normally wider than the rest of the foundation to provide bearing against the soil (see figures 5 and 81).

Geotechnical engineer—An engineer who specializes in the behavior of earth materials and who performs work such as evaluating the stability of natural slopes and man-made soil deposits, assessing risks posed by site conditions, and designing earthworks and structure foundations.

"Ghosts" of past construction—A difference in paint or other surface evidence that occurs around the former position of a structural element, appliance, or furniture, including darker or lighter flooring, paint outlines, and fastener holes (see figure 310).

Glazing—Panes of glass or other transparent or translucent material in a window.

Glazing points—Small metal triangles, diamonds, or winged shapes pushed into the wood window frame against a pane of glass to hold the glass in place before putty is applied (winged shapes are not appropriate for historic windows).

Gouge—A chisel with a concave blade (see figures 98 and 99).

Guano—Bat or sea bird feces; usually describes droppings concentrated in a small area that form a layer over a surface.

Joint—On shingle or shake roofs, a gap between horizontally adjacent shingles.

Hand plane—A handtool with a flat bottom housing a projecting steel blade, used to pare shavings from the surface to flatten and smooth wood. Usually has knobs or handles on top, in front of and behind the blade, to grasp while pushing the tool across the wood surface (see figure 102).

Heat shield—A sheet of nonflammable material installed on spacers to encourage a convection flow of air that prevents most of the heat from a wood stove or metal flue from reaching the combustible material behind the heat shield.

Hewing—Chopping or cutting a log with a broadaxe to create a relatively flat surface (see figures 124 and 125).

Knee wall—A partial-height wall that connects the floor and a low ceiling. Usually load bearing (see figure 5).

Lag screw—A heavy hex- or square-head wood screw.

Ledge and brace door—(also known as plank and batten) Several vertical boards tied together at the top and bottom by horizontal boards (called ledges or battens) to form a door. Sometimes includes a diagonal board (brace) that extends from the top ledge to the bottom ledge and fastens to each of the vertical boards to keep the door square (see figure 304).

Lite—A framed opening in a window or door containing a pane of glass or other translucent or transparent material (see figure 297).

Log cleat—A small steel device used to hold a log in a fixed position while the log is shaped. Normally available in pairs connected by a rope; the pointed ends grip the log and the surface it rests on (see figure 94).

Log dog—(also known as log staple) A steel bar with each end bent 90 degrees and sharpened. Available in various sizes and with either chisel or pointed ends that are pounded into a log and the surface it rests on to hold the log in a fixed position for shaping (see figure 94).

Log screw—A long, approximately ¼-inch-diameter wood screw available in lengths of about 4 to 16 inches, with only 3 inches of thread on the end; the rest of the shaft is smooth.

Mallet—A hammer with a large, cylindrical wooden or rubber head (see figure 91).

Markerboard—A board marked in measured intervals, attached to an object and used with a surveyor's level or transit to track vertical or horizontal movement (see figure 62).

Miner's wedges—Large wooden wedges with a shallow slope (see figure 56).

Mullions—Vertical window dividers that provide structural support (see figure 297).

Muntins—Strips of wood or metal separating and holding panes of glass in a window (see figure 297).

Needle—A metal or wooden beam extending the full width of a building to support the building while raising it or replacing the foundation or support structure (see figures 69 and 85).

Notching—A method of joining stacked log walls at the corners by carving shapes into the logs. Secure notching methods (saddle, half dovetail, full dovetail, "V," step and lock) alternately interlock end and side logs using shape alone, while less complex notches require fasteners (square, butt and pass) (see figures 16 through 21).

Pane—A single sheet of glass in a window or door (see figure 297).

Peavey—A lever tool with a hinged, hooked arm near the spiked end, used to grip and turn over a log; a cant hook with a spiked end (see figure 91).

Persuader—Big mallet (see figure 91). See definition of beetle mallet.

Pier—A pillar support for a structure, usually constructed of masonry (see figures 81 and 82).

Piling—Heavy beam or post driven vertically into the ground or sometimes set vertically into an excavated hole in the ground to support a structure.

Plank and batten door (also known as ledge and brace)—Several vertical boards tied together at the top and bottom by horizontal boards (called ledges or battens) to form a door. Sometimes includes a diagonal board (brace) that extends from the top ledge to the bottom ledge and fastens to each of the vertical boards to keep the door square (see figure 304).

Plumb—Precisely vertical.

Plumb bob—A heavy, usually conical weight on a fully flexible string or cord. Used to determine a precisely vertical line or whether a surface is vertical or leaning (see figure 45).

Pony wall—A partial-height wall that is not load bearing.

Power plane—A powertool with a flat bottom housing a rotating drive with projecting steel blades. Used to flatten and smooth wood by paring shavings from the surface (see figure 107).

Projectile point—A sharp-edged head for a projectile, such as an arrow, spear, or dart. Usually fashioned from chipped stone, metal, bone, or ivory (see figure 31).

Purlin—Log or timber roof support member running horizontally across the roof, supported by the end walls and sometimes a center wall of the cabin (see figure 205).

Putty—A soft, easily worked paste, traditionally made from whiting and linseed oil, that hardens over time and is used mostly for sealing windowpanes within their frames.

Rafter—Roof support member running from the peak to the eave of the roof, supported by the outside walls of the cabin and either braced against a rafter on the opposite side of the roof at the peak or supported by a ridge beam at the peak. Can be made of logs, timbers, or lumber (see figure 206).

Rafter tail—The portion of a rafter extending beyond the outside wall of a building (see figures 186 through 191).

Rail and stile door—(also known as frame and panel) A frame of vertical stiles and horizontal rails holding raised or flat panels in place to form a door (see figures 303 and 305).

Raking out—Removing mortar to a depth of about ¾ inch from the face of brick or other masonry (see figures 242 and 243).

Raker shingles or shakes—Shingles or shakes laid along the gable end or along an intersecting wall of a roof, perpendicular to normal shingle or shake orientation, to raise the edge of the finished roof enough to guide water back over the main part of the roof (see figure 239).

Reciprocating saw—A power saw with a narrow blade that cuts with a back-and-forth motion (see figure 101).

Roof jacks—(also known as toe board holders or slide guards) Metal plank holders that are nailed to the roof through angled slots. Used to support planks that provide a horizontal surface for the roofers' feet (see figure 201).

Rough sawn lumber—Lumber with a rough surface that wasn't planed after it was sawn. Such lumber has slightly larger actual dimensions than planed lumber with the same nominal dimensions.

Sash—The frame holding the glass in a window (see figure 297).

Sash cord—In single-hung or double-hung windows, a small rope that runs over a pulley wheel inside the window casing near the top of the window and connects each side of the window sash to a sash weight (see figure 297).

Sash weight—A counterweight used in single-hung or double-hung windows to make it easier to raise or lower a window sash, and to hold a window sash in place when it is raised or lowered (see figure 297).

Sawbuck—A device for holding rough or round wood so that it may be worked without rolling over or shifting. It consists of two vertical "X" forms stabilized by a connecting horizontal piece. The timber or log is placed in the upward facing "Vs" at the top of the "Xs", similar to the top rail of the sawbuck fence in figure E7.

Screw jack—A lifting jack consisting of a threaded rod that can be cranked up and down inside a threaded support, with a plate on the top end of the threaded rod to bear the load. Sometimes called a house jack if it's an appropriate size (see figure 60).

Scribe—A pointed instrument used to make guide marks on a surface. When used in construction, normally refers to a compass scribe which has two arms that can lock at a fixed distance apart and be used to transfer a shape from one surface to another (see figure 105).

Significant—When used in or as a shortened version of the phrase "historically significant," it means the building or site is important to the history, architecture, archaeology, engineering, or culture of a community, State, or country because of its association with important events, activities, or people; its distinctive physical characteristics; or its potential to yield important information.

Sill—A strong, horizontal structural member at the base of a structure, door, or window.

Sill log—The bottommost log (usually two per structure, on opposite sides) that supports the rest of a log building (see figures 4 and 151).

Single-hung window—Two-section window, typically taller than wide, one-half of which opens vertically (window on the right in figure 47).

Single-strength glass—Sheet glass that is about 1⁄16 inch thick, as opposed to double-strength glass, which is about 1⁄8 inch thick.

Sistering—Reinforcing a framing member by attaching it to another piece of lumber, usually of the same dimension, that is laid parallel and adjacent to the existing framing member.

Sleeper—Wood member resting on a surface or structural support, used to level or raise and support another part of a structure, such as a floor. Log sleepers sometimes were laid directly on soil to support log cabin sill logs and floor joists (see figure E9).

Slick—A large chisel driven by manual pressure, never struck (see figure 99).

Spandrel log—The second log from the bottom (usually two per structure, on opposite sides) that rests at its ends on the sill logs and supports the rest of a log building (see figures 4 and 151).

Spud bar—A long, straight metal bar generally used lengthwise as a handtool to jab an object, causing the object to move, break up, or deform. Some spud bars have a wood or fiberglass bar and wider steel chisel end for specific jobs, such as roofing tear-offs (shingle spud) or removing bark from logs (bark spud) (see figure 59).

Square—Enough roof material to cover about 100 square feet of roof.

Square—A flat L (framing square)- or triangular (speed square)-shaped tool, usually made of metal, commonly marked on the edges at measured intervals and inscribed with framing tables, used for marking right (90-degree) angles and sometimes other angles, spacing for wall studs, rafter angles, and so on (see figure 104).

Standard dimension lumber—Lumber sawn to match standard lumber dimensions listed in the U.S. Department of Commerce American Softwood Lumber Standard (ALS). Sometimes called “dimensioned” lumber.

Stem wall—A vertical foundation wall, usually constructed of concrete or masonry, extending from the footing upwards to support the perimeter walls and floor framing or slab, and to retain soils outside the crawl space or basement (see figure 5 and figures 83 through 86).

Sticker—Dry, unwarped wood, usually of small dimension, used to separate individual pieces of lumber to allow air to circulate and prevent the lumber from warping in storage.

Structural engineer—An engineer who is responsible for analyzing and designing the physical components that support a structure and withstand the forces exerted upon it by wind, earthquakes, snow, and so on.

Stub wall—A horizontal, short wall that “stubs” out from (and usually is perpendicular to) a full wall.

Tempered glass—A type of safety glass that is made by heating glass to about 1,200 °F and then blowing air on both sides to cool it quickly to about 500 °F, making it much stronger than standard glass and causing it to crumble into many small pieces when broken rather than shattering into shards.

Timber tongs—A pincer-like, hinged device with pointed grabbing ends, used to partially surround and hold logs or large timbers as they are lifted by a chain or bar attached at the hinge end (see figures 51 and 91).

Whalers—Paired timbers on either side of a wall that are through-bolted or nailed to the wall, creating a “sandwich” to stabilize the wall (see figures 65 and 68).

Wood grain—Refers to the orientation of wood cell fibers, which are visible in patterns of alternating darker and lighter wood.

Worm drive saw—A term typically used when referring to circular saws with a worm (screw form) shaft and wheel gear drive motors, which are heavier, more expensive, and more powerful than direct drive or sidewinder circular saws. Worm drive circular saws can be identified by the position of the motor parallel to the blade and the main handle behind the blade (see figure 101).

Appendix E—Log Building Origins and Styles

Plan and Form

As they moved westward, European-American settlers successfully adapted log construction techniques to regional materials, climates, and terrains (figures E1 and E2). The floor plan and shape of log buildings constructed in the 1700s and early 1800s sometimes can provide clues to the ethnic origin or route of migration of the original inhabitant or builder. Because the settlers often borrowed and copied techniques used successfully by their neighbors, don't infer too much about the ethnic origins of a cabin's builders from the way they constructed the cabin.

Figure E1—The two-story Gladie pioneer cabin, built around 1900, was restored as part of the Gladie Visitor Center pioneer homestead interpretive site in Kentucky (Daniel Boone National Forest, Southern Region). The builders constructed it of large diameter, hewn hardwood logs with half-dovetail notching and set it on elevated piers. It has a moderate pitch, hand-split shake roof, two full stories, and a stone fireplace on one end. The front and back doors are located under shed-roof porches on the long sides of the building.

Historians have identified a number of traditional cabin plans and forms as prototypes. People often repeated these prototypes with simple variations. Settlers across the country built one- and one-and-a-half-story versions of most of these plan types.

Figure E2—The builder of this cabin at the mouth of Big Timber Creek Canyon on the Big Timber Ranger District in Montana (Gallatin National Forest, Northern Region) used a stone foundation with massive, battered stone corners and porch piers, and moderate diameter, round, softwood log walls. The cabin has a steep cedar shingled roof and a rock chimney for a wood stove near the center of the building. The entry is on the gable end under a gabled porch. It was sold and removed from the site in the early 1980s.

The basic unit of each of these types is the one-room enclosure formed by four log walls joined at their corners, called a single pen or crib (figure E3). People sometimes divided the single pen by interior partitions or enlarged them by adding another log pen. The typically mid-Atlantic "continental"

Figure E3—The original one-and-a-half-story Slate Creek Ranger Station, built in 1909 on a tributary of the Salmon River in central Idaho, is a single pen style cabin. It has a single room on the ground floor that served as an office and kitchen. The inhabitants used space under the rafters, accessed by a steep stairway, for sleeping. It was moved several miles from its original location after a new ranger station site was acquired in the late 1950s. The cabin is now used to interpret the life of early forest rangers of the Nez Perce National Forest in the Northern Region.

plan consisted of a single pen subdivided into three rooms organized around a central hearth. This plan originated in central and eastern Europe. Eighteenth-century German immigrants probably brought it to Pennsylvania. The interior partition walls were not constructed of logs.

The saddlebag, or double pen plan (figure E4), was composed of two side-by-side log pens that usually shared a central chimney. Saddlebag buildings often resulted from adding a second pen onto the chimney end wall of a single pen.

The dogtrot plan (figure E5) had two pens separated by an open passageway (sometimes enclosed later), all covered by a continuous roof. People built variations of dogtrot buildings in many parts of the country, although the style sometimes is considered typically southern because its covered passageway provided air circulation and shelter from the heat.

The distinctive Rocky Mountain style cabin evolved in the West around the middle of the 19th century. Although the builders usually placed the entrance doorway to most early log cabins beneath the eaves, they placed the entrance to

Figure E4—Builders constructed the saddlebag style Pole Creek Ranger Station in 1905 with post corners, posts at the junction of the two pens, and small diameter log infill walls. The characteristic central chimney serves a wood stove, rather than a fireplace. The cabin is located in southeastern Idaho's Sawtooth National Recreation Area in the Intermountain Region.

Figure E5—Builders constructed the two-story, dogtrot style Wolf House of hand-hewn yellow pine logs in 1829 on Wolf family land as a county courthouse. It is the oldest public structure, and possibly the oldest standing building, in Arkansas. It has served many purposes over the years. The building, restored from 1999 to 2002, now serves as a museum. It is located across the White River from the Southern Region's Ozark-St. Francis National Forest Sylamore District in the town of Norfork.

Rocky Mountain style cabins in the gable end, probably as a means of adapting to the greater snowfall in the Rockies. A porch created by extending the roof beyond the gable wall usually protected the entrance. Two corner posts (figure E6) usually supported the porch roof, but sometimes intermediate posts also helped support the roof.

From the late 18th century, Americans built many substantial two-story log houses in towns throughout the country. In rural areas, they sometimes built two-story log houses to replace earlier cabins. Just as often, they added a second story to a single-story hewn-log house (figure E7). They accomplished the addition by removing the roof and gables, constructing a second floor, laying additional courses of logs, and building a new roof, or reassembling the old one. Sometimes, each generation of owners expanded a log building by adding on new log pens or masonry or wood frame extensions. They often added a rear “ell” or infill construction to link a formerly freestanding outbuilding, such as a kitchen, to the main house. Such a layering of alterations is part of the evolution of many log buildings.

Figure E6—The Pretty Prairie Station, built in Montana in 1924 on the Lewis and Clark National Forest in the Northern Region, is a classic Rocky Mountain style double pen log cabin.

Figure E7—This substantial building in Frisco, CO, began as a small log cabin. Over time, the owners constructed a two-story addition above and beside the original cabin and added a wing behind it.

Foundations

Most builders set their log cabins on foundations of some sort. To save time, some builders set their cabins on bare dirt. Cabins set directly on the ground usually had dirt floors and were intended as temporary shelters. Logs rot much more quickly when in contact with soil (figure E8) than when supported above the ground.

Figure E8—The builders constructed this cabin directly on the ground. The lowest logs of the cabin are rotting because the ground holds moisture against the logs, which enables fungi to invade the wood.

Log building foundations varied considerably in quality, material, and configuration, depending on when and where they were built, the climate, the builder's skill and knowledge, and the intended use of the structure. Builders frequently constructed the earliest log cabins on log pilings or log sleepers set directly on or in the ground (figure E9). If they intended to build a more permanent structure, they frequently used stone or brick piers that allowed air to circulate beneath the sill logs. Piers could be as simple as a large rock with a relatively flat top and bottom under each corner of the cabin (figure E10), or could consist of several courses of mortared or dry laid stone or brick. In warm, humid climates where wood decays more quickly, piers tended to be taller than in cooler or dryer climates. In cooler and drier climates, builders sometimes constructed mortared or dry laid rock walls to fill the spaces between the piers and discourage animals from crawling under the buildings.

Figure E9—The log sleepers that support the Clearwater Springs Ranger Station cabin are clearly visible under the log floor joists in this photo. The builders constructed the cabin in 1913 and used it as a summer station in the Blue Mountains (Pomeroy Ranger District, Umatilla National Forest, Pacific Northwest Region).

Figure E10—The builders constructed the assistant ranger's house at the Landmark Ranger Station on rock piers in 1936. The Landmark Ranger Station now is a seasonal-use guard station on the Cascade Ranger District in central Idaho (Boise National Forest, Intermountain Region).

Builders also commonly set log cabins on rock foundation walls, though the foundations seldom had footings and didn't usually extend very far under the surface of the soil. Builders generally didn't include full cellars in the original construction of most of the earliest log buildings, but later dug root cellars under a portion of some buildings. Concrete foundations and basements under log structures didn't become common until the early 1900s.

Corner Notching and Other Fastening Techniques

Corner notching is a characteristic feature of log construction. Most notching methods provide structural integrity by locking the log ends in place, providing rigidity and stability. Like the floor plan, the type of corner notching sometimes can be a clue to its age and the ethnic origin of a cabin's builders, but don't draw conclusions based only on notching details.

Builders used several corner-notching techniques throughout the country. Simple saddle notching (figure E11), which demands minimal time and hewing skill, may be the most common. "V" or steeple notching (figure E12) also is common. Full dovetail notching (figure E13) is one of the sturdiest notching techniques, but also is the most time-consuming to accomplish and requires a high level of craftsmanship. Half dovetail notching (figure E14) is more common because it provides nearly as secure a joint as full dovetail but is easier to craft. Square notching (figure E15) was secured with pegs or spikes because the logs did not interlock. A variation of square notching, called step and lock notching (figure E16), provided some stability. Historically, builders seldom used butt and pass corners. These corners require evenly sized or milled logs stacked in level rows, which alternately butt against and protrude past the perpendicular log, and must be fastened using pegs or spikes.

Figure E11—A saddle-notched cabin corner.

Figure E12—A steeple- or V-notched, cabin corner.

Figure E13—A full-dovetail-notched cabin corner.

Figure E14—A half-dovetail-notched cabin corner.

Figure E15—A square-notched cabin corner.

Figure E16—A step-and-lock-notched cabin corner.

Some of the earliest eastern cabins and most 19th-century western cabins (particularly those with saddle notching) had an extended log end or crown (figure E17) beyond the corner notches. The builders sometimes left the crown ends ragged, but often shaped them. Chopper-cut crown ends were wedge-shaped and oriented horizontally, vertically, alternately horizontally and vertically, or randomly (figure E18). The builders sometimes gave crown ends a conical or beaver-chewed shape. Rustic style structures, in particular, had pronounced or exaggerated crowns that people sometimes cut progressively shorter toward the top of the wall, creating a buttress effect at the corners of the building (figure E19). Builders frequently sawed ends evenly for a “Lincoln Log” look (figure E20). Builders seldom used extended crowns on buildings with dovetail or square notching and, of course, couldn’t use them on buildings with corner posts or boards.

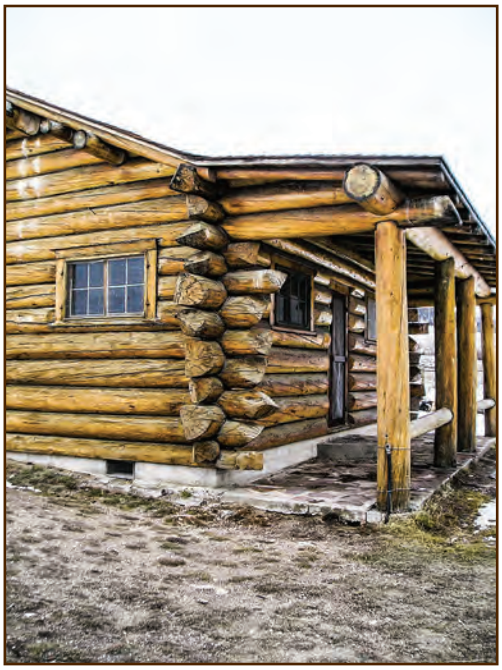

Figure E18—The random length and orientation chopper-cut crown ends extend beyond the corner notches on the Horse Prairie Guard Station (Beaverhead-Deerlodge National Forest, Northern Region).

Figure E17—Irregular, wedge-shaped crown ends that extend beyond the corner notches.

Figure E19—The crown ends of the logs at the corners of the rustic style Elk Creek Ranger Station Office are sawn longer near the ground for a buttress effect. The 1934 office is now a work station of the Lowman Ranger District (Boise National Forest, Intermountain Region) in southwestern Idaho.

Figure E20—The evenly sawn crown ends impart a "Lincoln Log" look to the porch of the 1907 Upper Mesa Falls Lodge. This two-story log structure with a veranda was closed in the 1930s. It reopened after the Targhee National Forest (Intermountain Region) partnered with the Idaho Department of Parks and Recreation to renovate the building in 1993.

Figure E21—The stage stop in Virginia Dale, CO, has a post and beam structure with stacked log infill walls. The original roof was cedar shingles.

Figure E22—The builders drove pegs through the corner posts into tenons of each wall log on the 1843 Zeigler House in Dalmatia, PA.

Some post and beam-supported buildings had stacked logs as infill walls between the posts (figure E21). Usually, builders pegged or nailed the log ends into the corner posts.

Builders sometimes carved tenons into the log ends and inserted them into grooves or mortise holes in the posts. They often drove pegs or nails through the corner post into the tenons of the wall logs (figure E22). These methods are referred to as post and beam or piéce sur piéce (log on log).

When the builders were in a hurry and not concerned about making the building last a long time, they sometimes used spikes, nails, or pegs to attach logs to vertical corner planks. This corner-fastening method is called hog trough (figure E23).

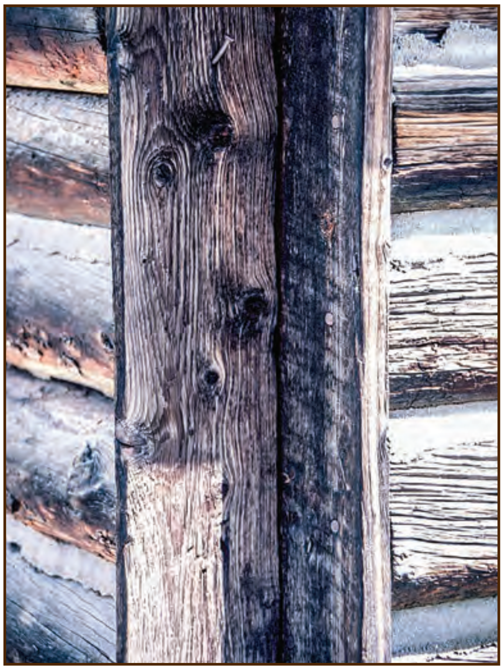

Figure E23—The nails are visible where the builder nailed this hog trough board corner to the stacked log walls.

In an even less common log construction method, builders positioned wall logs vertically, and usually secured them at the top to a roof plate and at the bottom to a sill plate. This method is called palisade or stockade construction (figure E24). If the wall logs are oriented vertically with wide straw- or horsehair-reinforced daubing, the construction may be referred to as poteaux sur sole (post on sill).

Figure E24—The builders constructed the first floor of this home in Frisco, CO, using stockade style log construction, except at the windows, where they stacked the logs horizontally.

Selecting Logs

Although availability was the main factor influencing the species of trees settlers selected for use in historic log construction, they usually preferred long, straight, rot-resistant logs. In the East and Midwest, they commonly chose chestnut and white oak. Cabin builders also used northern white cedar, fir, and pine in areas where those species were plentiful. In the Southeast, people used cypress where it was available. West of the Cascade Mountains in the Pacific Northwest and in coastal Alaska, people chose western red cedar, yellow cedar, or Port Orford cedar because these species were rot resistant. People sometimes preferred Douglas fir because its long, straight trunk had little taper. Settlers chose redwood in northern California for both its rot resistance and straight trunks. Cabin builders chose Douglas fir and larch (sometimes called tamarack) in the inland Pacific Northwest and Rocky Mountains where the trees were available. They chose Ponderosa pine and lodgepole pine where Douglas fir or larch weren't available.

When people were in a hurry and didn't intend to stay in a cabin for more than a few years, they tended to be less picky about log species. They often used whatever trees were closest at hand, including aspen and cottonwood. Aspen, cottonwood, and other poplar species deteriorate quickly if they're not kept dry, but are relatively easy to shape. Nondurable species choices were particularly typical of miners' cabins during gold rush periods.

Builders sometimes constructed cabins using more than one species. They used harder, heavier, rot-resistant wood, such as white oak, for the foundation and sill logs, but might use lighter, more easily hewn wood, such as yellow poplar, for the upper log courses.

Tools and Shaping the Logs

One reason builders commonly constructed pioneer cabins of logs is that a log cabin doesn't require many different tools to construct. If necessary, a log cabin could be built using as few as two tools: a felling axe and a crosscut saw.

A log cabin builder used a felling axe or crosscut saw to chop or saw down the tree and cut the logs to length. If the builder didn't cut trees immediately adjacent to the cabin location, he used horses to skid the logs to the cabin site (figure E25). Builders debarked logs using a drawknife, but if they had no knife or were in a hurry, they could use the logs without removing the bark.

Figure E25—Builders used a team of horses to drag logs to the location where they constructed the original Slate Creek Ranger Station (Nez Perce National Forest, Northern Region) in 1909.

Most builders constructed cabins of round logs (figure E26), but they sometimes sawed logs into thick planks, or used a broadaxe or adz to hew one or more sides of the logs flat (figure E27). Similarly, most builders used round logs for roof framing and floor joists, but sometimes hewed or sawed them from larger logs.

Builders found log dogs handy to keep logs in place while working on them. They used an axe, hatchet, or saw to make notches. Sometimes they used a log scribe (figure E28) to mark the notch and a chisel to make the cuts more precise. To

Figure E26— The builders constructed the Stolle Meadows Guard Station on the Cascade Ranger District (Boise National Forest, Intermountain Region) in central Idaho using round logs carefully selected for similar size and little taper.

Figure E28—An assortment of older log scribes.

Figure E27—The builders constructed the Switzer House in Nevada City, MT, using hewn logs. This building is one of just a few log duplexes ever built.

Figure E29—This crew of three men used ropes and skid logs to raise the logs into place on the upper portions of the walls of the Slate Creek Ranger Station (Nez Perce National Forest, Northern Region) during construction in 1909.

make a tight cope, they sometimes used a log scribe to mark the contour of the lower log on the upper log.

Using skid poles and ropes, only a few people are necessary to raise logs into position (figure E29). Although people usually notched the logs at the top and bottom of windows and doors as they set them, they usually sawed out the rest of the logs for these openings after setting all the logs into place.

Sometimes the builders allowed the log structure to season and settle for a year before cutting window and door openings. After cutting the openings, they immediately framed them to help hold the logs in place.

Whether builders used two, eight, or more tools to build a log cabin, log cabin construction was far less complex than the post-and-beam, masonry, or balloon framing practices that builders commonly used in urban areas.

Chinking, Daubing, and Coping

Builders usually filled the horizontal spaces or joints between logs with a combination of materials, called chinking and daubing. Chinking and daubing seal the gaps between the logs in the exterior walls, protecting the building interior against driving wind and snow, blocking the entry of vermin, and helping the walls shed rain. Chinking refers to filler materials and daubing refers to the material used to seal out weather and provide a finished surface. People used chinking and daubing between logs because it was faster and easier than hewing or coping the logs to fit tightly together.

Figure E30—The builders used slate as chinking between the logs on this cabin. They laid the pieces of slate on wood blocking to angle them toward the outside of the building to help shed rain.

Builders filled and finished the spaces between cabin logs in many ways (see figure 192). Methods depended on available materials, the determination of the builder to seal the gap, the desired appearance of the joint, and the builder's skill. Historical chinking and daubing generally consisted of materials the builder could find nearby or obtain easily. The size of the joints between the logs dictated the amount of chinking and daubing necessary. If the joint gaps were significant, the builder needed both chinking and daubing. If the joint gaps were small, it is likely that the builder only used daubing.

If the gaps between the logs were large, chinking could be a two-part system. First, the builder stuffed a dry, bulky, rigid blocking, such as wood slabs or stones (figure E30), into the joint. Next, the builder used soft packing filler, such as oakum (figure E31), moss, clay, fabric, newspaper, or dried animal dung, to fill the cracks between the blocking. Sometimes the builder tacked nails in on the lower log to hold the blocking or filler in place before applying the daubing to cover both the chinking and the nails.

Figure E31—The builders used oakum for chinking on the office/cookhouse building at the Moose Creek Wilderness Station (Nez Perce National Forest, Northern Region), built in 1921.

Daubing, which completes the system, is the outer finish layer (figure E32). Daubing traditionally was a wet-troweled mixture of some combination of sand, clay, and lime (figure E33) and, after 1900, sometimes included Portland cement in addition to or completely replacing the lime. Builders often sloped daubing to protect the tops of logs and shed rain.

Sometimes builders used narrow wood strips as an edging for the daubing (figure E34). Occasionally, they used more inventive methods, such as wire tacked to the logs, as reinforcement for the daubing (figure E35). Builders often used nails only partially driven into the logs as a sort of reinforcement to help keep the daubing in place.

Figure E32—The builders sloped the finely crafted daubing on this hewn log home to shed rain and protect the tops of the logs.

Figure E34—The builders used small pieces of wood trim as edging for the sloped daubing on this hewn log cabin. Preservation crewmembers replaced some of the edging (brighter colored wood) when they repaired the daubing.

Figure E33—The daubing on this cabin in Sunlight Basin in Wyoming has an unusual texture. It probably was made using local limestone or sand that contained the fossilized remains of small sea creatures. The cabin originally was part of a homestead ranch, but now is part of a Wyoming Game and Fish field station.

Figure E35—The builders tacked smooth wire to the logs in a zig-zag pattern to provide reinforcing for the daubing on the Fritz Cabin (Dubois Ranger District, Caribou-Targhee National Forest, Intermountain Region).

On some cabins, builders used wood strips or split log poles to cover the gaps between logs (figure E36). They daubed some cabins using tar instead of a mortar-like mix, creating a black line between logs (figure E37) rather than a white line.

Figure E36—The builders used carefully shaped and fitted quartersawn poles instead of daubing on this cabin.

Figure E37—The tar daubing on the 1935 Horse Prairie Guard Station (Beaverhead-Deerlodge National Forest, Northern Region), a fairly common daubing material choice in the Northern Region during that time period, has the effect of accenting the joints between logs.

Daubing mixes are sturdy but are, by design, the least durable part of a log building. Logs expand and contract with changes in temperature and humidity and, like all buildings, log cabins settle a little over time. When cabins settle, part of the structure has to give. Fortunately what gives normally is something that is easy to replace: the daubing. Daubing is also susceptible to cracking because of freeze-thaw cycles.

Sometimes, when daubing cracks and falls out from between the logs, chinking also falls out. Inspect chinking and daubing regularly and patch or replace it whenever you observe damage.

Tight-fitting plank-hewn or scribed-fit round logs have little or no need for chinking and daubing. People usually refer to scribed-fit round logs as “coped” or “Swedish coped” logs (figure E38). Coping was more typical of Swedish or Finnish techniques, and was not as common in American log construction until the 1900s.

Figure E38—The builders coped the logs of this workshop, providing a tight fit between the logs. They used small wood inserts to more completely seal the space between logs at the crown ends, but daubing was not necessary. The workshop originally was a small barn built in 1936 on the Crandall Ranger Station (Shoshone National Forest, Rocky Mountain Region).

To provide ventilation, people constructed some log buildings with intentional gaps between logs and didn't use chinking or daubing. Corncribs, barns (figure E39), and other storage buildings often have intentional gaps between the logs.

Figure E39—The builders intentionally spaced the logs of this barn to provide ventilation at the Moose Creek Wilderness Station (Nez Perce National Forest, Northern Region) in north central Idaho.

Exterior Wall Treatments

The builders didn't cover the exterior logs of most early cabins with siding materials when they originally constructed them. Owners eventually covered many 18th- and 19th-century log houses, especially those east of the Mississippi, with exterior wood lap siding, shingle siding, or stucco. The owners felt the siding provided a more finished, fashionable, or prosperous appearance. The siding or stucco also helped insulate and protect the logs from weather and insects. The owners generally nailed vertical wood furring strips to the logs before applying siding or stucco. The furring provided an even base on which to nail the siding or wood lath for stucco. Builders could adjust furring thickness so the finished wall surface would be plumb.

Siding and trim could disguise the cabin's simple construction beneath Georgian, Federal, and other architectural styles (figure E40). To harmonize the whole, owners frequently covered—or recovered—log houses with siding when they erected an addition, especially if the addition was wood frame construction. Owners gave some log buildings, especially those used as businesses, framed and sided fronts (figure E41), usually with an extended height that hid the gable end of the roof (called a false front), to make the building appear more imposing and conform to current styles.

Figure E40—The owner added frame window bays and trim to this log home in Breckenridge, CO, to achieve a Queen Anne style.

Figure E41—The owner added a false front consisting mainly of windows and clapboard siding to this log building in South Pass City, WY, to make it look more substantial and prosperous. *Photo © Andrew Gulliford; used with permission.*

In some instances, owners whitewashed the surface of the logs on the outside (figure E42) or the inside of the cabin. Whitewash is a very low-cost type of paint made from slaked lime (calcium hydroxide), chalk (whiting), and sometimes coloring agents or other additives. Whitewash discourages insects and seals hairline cracks in the daubing and between the daubing and logs. Whitewash is not a very durable paint; like daubing, it must periodically be reapplied.

Owners didn't usually cover 20th-century rustic-style log buildings with siding, because the logs were intrinsic to the desired appearance of the buildings. Owners frequently oiled, varnished, or stained the logs to emphasize the rustic appearance and to protect the logs.

Figure E42—The logs of the Ryburn House at Bannack State Park in Montana are whitewashed. The L-shaped building has a cross gable roof.

Roofs

Builders framed the roofs of historic log buildings with a variety of different systems. Like log house plans and corner notching styles, the roof-framing systems often were variations on ethnic and regional carpentry traditions. Purlin-framed roofs are more typical of Scandinavian construction, western cabins, and 20th-century rustic styles. Rafters are more common east of the Mississippi River. Trusses also are more common east of the Mississippi River, and in wide buildings. People made earlier trusses with wood mortises, tenons, and pegs, but iron or steel rods and tie plates became more common after the mid-1800s. Purlins, rafters, and trusses for log cabin roofs usually are round logs, but sometimes are hewn or sawn. All three roof-framing methods are found throughout the country.

Builders nearly always used logs to construct the upper gable walls of log cabins if purlins supported the roof. They commonly used vertical or horizontal siding to cover pole-framed or sawn wood-framed gables when they framed roofs with rafters or trusses.

Although simple gables (figure E43) are the most common roof shape for log cabins, the shapes of log building roofs are as diverse as those for any other kind of building. Cross

Figure E43—The Big Prairie Ranger Station in northwest Montana (Flathead National Forest, Northern Region) has a simple gable roof covered with cedar shakes.

gables (see figure E42), gambrels (figure E44), jerkin head (or clipped gable) (figure E45), hip (figure E46), shed, and pyramid (figure E47) roofs all can be found on log buildings.

Figure E44—This barn at Shennago Creek Ranger Station (Gallatin National Forest, Northern Region) in Montana has a gambrel roof with a shed roof extension on one side.

Figure E45—The Johnny Sack Cabin at Big Springs in southeast Idaho has a jerkin head (or clipped gable) style roof. The owner constructed it in the early 1930s on land leased from the Forest Service. It now serves as a visitor information center jointly managed by the Caribou-Targhee National Forest (Intermountain Region), Fremont County Parks and Recreation, and the Island Park Historical Society.

Figure E46—The Big Creek cabin (Gallatin National Forest, Northern Region) in Montana has a hip roof (and a broken window that was later repaired).

Figure E47—The two-story Judith Ranger Station (Lewis and Clark National Forest, Northern Region) in central Montana has a pyramidal roof covered with cedar shingles.

Builders used wood shakes installed directly on purlins or on lath or shingles on solid or skip sheathing as the original roof covering for most log cabins. They preferred cedar shingles (see figure E42) or shakes (see figure E43) where cedar was available; cedar is rot-resistant and easier to split into shingles or shakes than most other species. As wood shingle roofs deteriorated, some owners replaced them with standing seam or ribbed metal roofs (figure E48), many of which continue to provide good service today. Later settlers west of the Mississippi were likely to roof their log buildings with metal or asphalt rolled roofing (figure E49). Settlers sometimes constructed sod roofs (figure E50) on log cabins built in grassland areas. Owners reroofed some older log buildings in the 20th century with asphalt shingles. For some rustic log buildings in the West and for some Great Camps in the Adirondacks, builders used asphalt shingles for the original roof material.

Figure E48—The owner replaced the original roofing on this log cabin in Sunlight Basin in Wyoming with ribbed metal roofing at some point during its history. Replacing historic roofing materials with modern materials usually is not recommended. The cabin originally was part of a homestead ranch that operated as a dude ranch during much of the early and mid 20th century. It now is part of a Wyoming Game and Fish field station.

Figure E49—The Hogback cabin (Lolo National Forest, Northern Region) has unusual vertically applied asphalt rolled roofing. This photo shows new roofing that is identical to the original roofing.

Figure E50—This log cabin at Fort McPherson in Nebraska has a sod roof. "Buffalo" Bill Cody built the cabin for his family while he served as a scout for the U.S. Army's 5th Cavalry; they moved there in 1870. *Photo © Andrew Gulliford; used with permission.*

Chimneys, Fireplaces, and Wood Stoves

Ethnic tradition and regional adaptation also influenced fireplace and chimney construction and placement. Builders usually constructed chimneys in early log cabins of stone or brick, a combination of the two, or even clay-lined, notched logs or smaller sticks. Later builders frequently installed metal flues and wood stoves instead of fireplaces. The chimneys or flues of log buildings erected in cold climates tended to be located entirely inside the house (figure E51) to maximize heat retention. In the South, where winters were less severe, builders typically constructed the chimney outside the log walls (figure E52) to minimize the heat added to the building interior during summer cooking. With the advent of more efficient heating systems, owners frequently demolished interior chimneys or relocated and rebuilt them to maximize interior space.

Figure E51—Ranger James Cayton built the Cayton Ranger Station in 1909 as a combination house and office. The house had an internal chimney. Cayton was one of the original 75 Forest Service rangers. *Photo © Andrew Gulliford; used with permission.*

Figure E52—This small cabin, built shortly after the Civil War, was the original structure for the school that eventually became Berry College in Rome, GA. The log exterior surface of the fireplace and flue is unusual. *Photo © Andrew Gulliford; used with permission.*

Appendix F—Acquiring Tools and Materials

Historic preservation work requires the use of specialized tools, supplies, and equipment that may not be available at your local hardware store. The following lists will help you locate what you need.

These lists are based on the author's opinion and the availability of items at Missoula, MT. Inclusion in this list only indicates where products may be procured. It does not constitute an endorsement by the Forest Service of any particular product or supplier. You may find different brands available in your area that work better for you. The costs listed are current as of the publication date, but they surely will change over time.

Tool Brands and Sources

Axes and hatchets

Gränsfors Bruks US <http://www.gransforsbruk.com/en/>. Handcrafted, high quality tools. Cost: $160 to $247.

Ben Meadows <http://www.benmeadows.com/>. Cost: about $50–$200.

Forestry Suppliers <http://www.forestry-suppliers.com/>. Cost: about $50–$200.

Garrett-Wade <http://www.garrettwade.com>. Cost: about $50–$200.

Lee Valley <http://www.leevalley.com/us/>. Cost: about $50–$200.

Schroeder Log Home Supply <http://www.loghelp.com>. Cost: about $50–$200.

Traditional Woodworker <http://www.traditionalwoodworker.com/>. Cost: about $50–$200.

Woodcraft <http://www.woodcraft.com/>. Cost: about $50–$200.

Bevel gauge or sliding T-bevel—These bevel gauges work better than those with the wingnut; they are easier to tighten and they stay tightened longer.

Amazon <http:www.amazon.com>. Search for "Sliding T-Bevel," 10-inch blade. Cost: $27.

Broadaxes

Schroeder Log Home Supply, Inc., <http://www.loghelp.com>. Cost: $363.

Gränsfors Bruks US <http://www.gransforsbruk.com/en/>. Cost: $300 to $840.

Chisels—For do-everything chisels, pick up any metal-ended chisel **(Stanley, Ace, Fuller Tool, Great Neck, etc.).** Cost: $10 to $20 per chisel. Chisel sets available.

Commandette mallets and beetle mallets or persuaders—Do not purchase mallets without metal or rawhide bands circling the head; they will not last long. The author is still looking for a source for commander mallets.

Log Home Store <http://www.aloghomestore.com>. Cost: $72.

Japan Woodworker <http://www.japanwoodworker.com>. Cost: $69 to $77.

Smith and Speed Mercantile <http://www.smithandspeed.com>. Cost: $76.

Drawknives

Barr Specialty Tools <http://www.barrtools.com>. Barr drawknives are very high quality—also buy the leather guards. Cost: $127 to $157.

Schroeder Log Home Supply, Inc., <http://www.loghelp.com>. Cost: $127 to $157.

Framing chisels—Only use wooden mallets with framing chisels.

Barr Specialty Tools <http://www.barrtools.com>. Barr makes high quality framing chisels—expensive, but worth it. Be sure to also buy the leather tip guards or find or make a durable chisel roll. Cost: $105 to $109 per chisel.

Lee Valley Tools <http://www.leevalley.com/us/>. Lee Valley carries Sorby chisels. Cost: $69 to $94 per chisel.

Log Home Store <http://www.aloghomestore.com>. Log Home Store carries Barr, Sorby, and Japanese chisels. Cost: $84 to $127 per chisel.

Schroeder Log Home Supply, Inc., <http://www.loghelp.com>. Schroeder carries Barr, Crown/Hamlet, Curry & Co., and Sorby chisels. Cost: $50–$180 per chisel.

Woodcraft <http://www.woodcraft.com>. The Pinnacle Socket Firmer chisels are very good, as are the Irwin/Marples blue-handled chisels. Cost: $41 to $134 per chisel. Chisel sets available.

Garment steamer—Use for paint removal.

Olde Window Restorer <http://www.oldewindowrestorer.com>. Cost: $279.

Ink pencils—Sanford NoBlot Ink Pencil, #705, with blue ink.

Log Home Store <http://www.aloghomestore.com>. Cost: $10 for 12 pencils.

Pencil Things <http://www.pencilthings.com>. According to Pencil Things, the Sanford NoBlot Ink Pencil is discontinued. They are replacing it with the PencilThings Select Indelible Ink Pencil. Cost: $17 for 12 pencils.

Log cleats (also called log dogs)

Schroeder Log Home Supply, Inc., <http://www.loghelp.com>. Cost: $42 to $63.

Or check with your local metalworking shop to see if they can make these.

Log or tree calipers—Buy at least a 24-inch caliper and make sure the gradations are in inches.

Ben Meadows Company <http://www.benmeadows.com>. Cost: $145 to $179.

Forestry Suppliers <http://www.forestry-suppliers.com>. Cost: $14 to $179.

Mallets—Lignostone mallets' laminated head takes a serious beating without splitting but, unfortunately, they are difficult to locate. You may be able to find Lignostone mallets on eBay.

Barr Specialty Tools <http://www.barrtools.com>. Barr has a variety of mallets. Cost: $35 to $62.

Japan Woodworker <http://www.japanwoodworker.com>. Japan Woodworker has a variety of mallets. Cost: $8 to $35.

Log Home Store <http://www.aloghomestore.com>. Log Home Store carries a variety of mallets. Cost: $17 to $27.

Schroeder Log Home Supply, Inc., <http://www.loghelp.com>. Schroeder has a beechwood mallet. Cost: $18.

Woodcraft <http://www.woodcraft.com>. Woodcraft has beechwood mallets. Cost: $25.

Masonry tools—Handy tools to have include a variety of sizes of pointing trowels, margin trowels, tuck pointers, a bucket trowel or two, hawks, and mixing pans.

Grainger <http://www.grainger.com> carries most of the items:

4JB18—Mason's Tool Kit—includes canvas bag, 11-inch brick trowel with soft grip handle, 6- x 2¾-inch pointing trowel, 5- x 2-inch margin trowel, ½- x 5⁄8-inch brick jointer, wood line blocks, mason's line winder with 250 feet of braided fluorescent yellow line, masonry brush, and joint raker.

2MRH7—Margin trowel, 1½ inch wide.

2MPY4—Hawk.

5LN46—¼-inch tuck pointer.

5LN48—½-inch tuck pointer.

5LN47—⅜-inch tuck pointer.

2MVR8—Mortar hoe.

Marshalltown <http://www.marshalltown.com> has other masonry supplies, such as 10102—bucket trowels

Nail strippers—Be sure to specify right or left hand.

Work Proven PO Box 3786, 5393 Hamm Road, Belgrade, MT 59714. 406–586–4727. Cost: $32 to $40.

Roofmaster Products Company <http://www.roofmaster.com>. Cost: $32 to $40.

Screw jacks

McMaster-Carr <http://www.mcmaster.com>. Item Numbers: 2926T13, 2926T14, 2926T16, 2926T18, 2926T19, 2926T21, 2926T24, 2926T27. Cost: $120 to $340.

Also check with your **local house or building moving company**.

Screw jacks (baby)

McMaster-Carr <http://www.mcmaster.com>. Item Number: 2915T21, miniature jacks with a non-swivel head. Cost: $70.

Screw jack turning bars—Use lengths of cold rolled steel for turning bars or purchase them from McMaster-Carr. Item Numbers: 2926T42, 2926T43, 2926T44. Cost: $30 to $79.

Scribers—If you are in Missoula, you also can buy these at the Montana Tool Company.

Veritas Tools, Inc., <http://www.veritastools.com/>. The Veritas scriber works well, along with the Veritas indelible pencils. Cost: $99 to $150.

Lee Valley Tools <http://www.leevalley.com>. Cost: $99 to $150.

Log Home Store <http://www.aloghomestore.com>. Cost: $99 to $150.

Schroeder Log Home Supply, Inc., <http://www.loghelp.com>. Cost: $99 to $150.

Smith and Speed Mercantile <http://www.smithandspeed.com>. Cost: $99 to $150.

Sharpening stones—Use rectangular stones for chisels and planes and round stones for axes and drawknives. Lee Valley and Woodcraft have a variety of water and oil stones, as well as honing guides and stone holders. A series of combination water stones are a good start—250/1000, 800/4000, and 1000/6000.

Lee Valley <http://www.leevalley.com>. Cost: $20 to $100 per stone.

Woodcraft <http://www.woodcraft.com>. Cost: $20 to $100 per stone.

Shingle hatchet—Get the ¾-pound head with the 3-inch cutting head.

Ben Meadows Company <http://www.benmeadows.com>. Cost: $40 to $45.

Estwing <http://www.estwing.com>. Estwing refers to this as a “carpenter’s hatchet,” E3-1H. Cost: $40 to $45.

Roofmaster Products Company <http://www.roofmaster.com>. You might have to ask for this hatchet specifically; it isn’t in the current online catalog. Roofmaster’s product number is ESTEC-1H, EC-1H Carpenter’s Hatchet with Nylon Vinyl Grip. Cost: $40 to $45.

Slicks

Barr Specialty Tools <http://www.barrtools.com>. Again, Barr tools are very high quality. Buy the leather guards. Cost: $144 to $165.

Schroeder Log Home Supply, Inc., <http://www.loghelp.com>. Cost: $144 to $156.

Split ring cutters—You need a drill with enough power to run the cutter head, such as a Milwaukee Hole Hawg drill. Once you have the cutter head, build a sturdy box for it—resharpening the cutters is difficult.

Cleveland Steel <http://www.clevelandsteel.com>. This supplier calls these TECO Split Rings, and supplies both the rings and cutter heads. Call for prices.

Portland Bolt and Manufacturing Company <http://www.portlandbolt.com/products/others/splitrings.html>. This company supplies both rings and cutters. Call for prices.

Steel band clamps

Jorgensen <http://www.ponytools.com>. Jorgensen Band Clamp Number 6230-S. Cost: $76.

Window glass cutter—Any hardware store carries glass cutters. For example:

Ace Hardware <http://www.acehardware.com>. Item 01-511. Cost: $15.

Window glass pliers—Any hardware store carries glass pliers. For example:

Ace Hardware <http://www.acehardware.com>. Item 06-112. Cost: $18.

Window hammers—Sometimes called the "picture framing hammer" or "glazing hammer"—for best results, after you get the hammer, grind off the rounded edges of the triangular head. That will keep the head from slipping when you (gently!) pound in the triangular glazing points.

Lee Valley <http://www.leevalley.com>. Cost: $24.

Window putty knives

Marshalltown <http://www.marshalltown.com/>.

Item 15067—1¼-inch flexible putty knife. Cost: $10.

Item 15064—¾-inch, 20-degree bent putty knife. Cost: $11.

Item 15065—¾-inch, 35-degree bent putty knife. Cost: $11.

Item 15084—5 way painter's tool. Cost: $12.

Item 15068—1½-inch chisel edge stiff putty knife. Cost: $10.

Item 15075—2-inch stiff putty knife. Cost: $11.

Item 15077—3-inch flexible putty knife. Cost: $13.

Window scrapers

Marshalltown <http://www.marshalltown.com/>. Item 19483 Profile Scraper—this scraper set comes with 7 different profiles. Cost: $29.

Jamestown Distributors <http://www.jamestowndistributors.com>. The three most useful types of window scraper are the triangle, 2-inch-wide, and 2½-inch-wide scrapers. Carbide double-sided scraper blades for the BTI-650 and BTI-665, and triangular scraper blades for the BTI-625 can be flipped over when one side wears out.

Item BTI-625—triangle scraper. Cost: $26.

Item BTI-650—2-inch-wide scraper. Cost: $25.

Item BTI-66—2½-inch-wide scraper. Cost: $32.

Olde Window Restorer <http://www.oldewindowrestorer.com>. Cost: $30, including blades.

Yankee screwdrivers—Also available at **Montana Tool Company in Missoula** and occasionally at **antique stores**.

Garrett Wade <http://www.garrettwade.com>. Comes with a hex head chuck. Cost: $76 to $99.

Traditional Woodworker <http://www.traditionalwoodworker.com>. Cost: $50 to $60. Also, get the hex head adapter. Cost: $18.

Material Brands and Sources

Appliances

Antique Appliances <http://www.antiqueappliances.com/index.htm>.

Elmira Stove Works <http://www.elmirastoveworks.com/>.

Good Time Stove Company <http://www.goodtimestove.com>.

The Renovator's Supply, Inc., <http://www.rensup.com/>.

Vintage Appliances and Restoration <http://antiquevintageappliances.com/>.

Vintage Tub & Bath <http://www.vintagetub.com/>.

Cedar Shake & Shingle Bureau

The **Cedar Shake & Shingle Bureau** <http://www.cedarbureau.org> promotes and protects the common interests of its members involved in quality cedar shake and shingle roofing and sidewall businesses. They also maintain a list of cedar shingle and shake suppliers.

Epoxy—Several brands of epoxies are available. The Northern Region Historic Preservation Team uses epoxies from System Three Resins.

System Three Resins, Inc., <http://www.systemthree.com>. A complete epoxy order (cost: $298) consists of:

0100A24—Epoxy resin, 2 gallons (the mix ratio is 2:1 for resin and hardener).

0101B24—Hardener #1, 1 gallon.

3105S47—Silica, 5 quart tub.

3003S99—12 ounce paper cups (with the measurements on the side).

3040S99—Mixing sticks.

3202A04—Brown color paste pigment, 2 ounce.

You also will need 1 gallon of white vinegar (to clean up the epoxy), disposable gloves, rags, and a box to keep everything together.

Another useful item is System Three Resins SculpWood two-part filler. The two pint kit is 1600K16. Cost $36.

Flooring and tile—A partial list of suppliers of resilient flooring suitable for use in early 20th-century buildings is available in the publication "Early 20th-Century Building Materials: Resilient Flooring," available to Forest Service and Bureau of Land Management employees at <http://fsweb.mtdc.wo.fs.fed.us/php/library_card.php?p_num=0773%202322>.

Canvasworks Floor Cloths <http://canvasworksfloorcloths.com/>.

Designs in Tile <http://www.designsintile.com/>.

General hardware

Crown City Hardware <http://www.restoration.com/>.

Oak Park Home Hardware <http://www.oakparkhome-hardware.com/>.

Rejuvenation <http://www.rejuvenation.com/>.

Shop 4 Classics <http://www.shop4classics.com/>.

Glazing points—Use triangular- or diamond-shaped glazing points. You can install triangular points with a window hammer (described previously) and diamond points with a specialty driver. If you have a driver, be sure it doesn't have a sole or foot, because the points must be level with the glass. You usually can get glazing points at your **local hardware store**.

Lighting fixtures

Brass Light Gallery <http://www.brasslight.com/>.

Grand Light <http://www.lightrestoration.com/>.

Oak Park Home Hardware <http://www.oakparkhome-hardware.com/>.

Rejuvenation <http://www.rejuvenation.com/>.

The Renovator's Supply, Inc., <http://www.rensup.com/>.

Oakum—Use oiled oakum.

Schroeder Log Home Supply, Inc., <http://www.loghelp.com>. Cost: $233 for 50 pounds.

Plumbing Fixtures

The Renovator's Supply, Inc., <http://www.rensup.com/>.

Rejuvenation <http://www.rejuvenation.com/>.

Shop 4 Classics <http://www.shop4classics.com/>.

Signature Hardware <http://www.signaturehardware.com/>.

Vintage Tub & Bath <http://www.vintagetub.com/>.

Sheet lead—Use 4-pound lead, which is 4 pounds-per-square-foot and about 1/16 inch thick.

Call **metal shops** to see if they stock it.

Mayco Industries <http://www.maycoindustries.com>. Mayco has a number of distributors.

Shingle stain, "Forest Service green"

Amteco <http://www.amteco.com>, or 800–969–4811. Amteco custom mixes Total Wood Protectant in color 318, which matches the dark green the Forest Service historically used for shingles. There is a 50 gallon minimum order, available in either 1- or 5-gallon pails. One gallon of stain usually covers a square of roofing. Two coats may be necessary. Cost: around $45.50 per gallon or $222.50 per 5-gallon bucket.

Split-ring connectors—These companies also supply the cutters for their rings. See the Tool Brands and Sources section of this appendix.

Cleveland Steel <http://www.clevelandsteel.com>. This supplier calls these TECO Split Rings. Call for prices.

Portland Bolt and Manufacturing Company (split rings) <http://www.portlandbolt.com/products/others/splitrings.html>. Call for prices.

Tar—Used with a caulking gun to apply daubing.

Black Jack All-Weather Roof Cement (red tube); available at **building supply and hardware stores.**

If you can't find Black Jack, try Premier brand Wet or Dry Plastic Roof Cement, also available at **building supply and hardware stores.**

If you can't find either one, use a tar-based roof cement that dries to a shiny or semi-shiny finish and stays somewhat elastic.

Window putty

Crawford's Natural Blend Painter's Putty <http://crawfordproducts.co/>. This is a linseed oil-based putty, so it works very well in wood windows. It comes in a bright orange can. The website lists dealers. It's also available at:

Columbia Paint <http://www.columbiapaint.com>. Cost: $15 per quart.

Weather stripping

Architectural Resource Center

The weather stripping with the brush is called Timber Seal Weather Strip (get the ¼ inch size) <http://www.architecturalresourcecenter.com/timber-seal-fin-seal-weather-strip/>.

The black bulb weather stripping is called Bulb and Leaf Weather Strip <hhttp://www.architecturalresourcecenter.com/bulb-vinyl-silicon-leaf-weather-stripping/>. Call for prices.

Window and door hardware

House of Antique Hardware <http://www.houseofantiquehardware.com>.

Rejuvenation <http://www.rejuvenation.com>.

Historic Home Hardware <http://www.historichomehardware.com>.

The Renovator's Supply, Inc., <http://www.rensup.com/>.

Appendix G—Support Organizations and Publications

Useful Catalogs and Websites To Have on Hand or To Bookmark

Architectural Resource Center <http://www.architecturalresourcecenter.com/>.

Ben Meadows Company <http://www.benmeadows.com>.

Forestry Suppliers <http://www.forestry-suppliers.com>.

Garrett Wade <http://www.garrettwade.com>.

Grainger <http://www.grainger.com>. Set up a Government account for General Services Administration pricing.

Historic Home Hardware <http://www.historichomehardware.com>.

House of Antique Hardware <http://www.houseofantiquehardware.com>.

John Leeke's Historic Homeworks <http://www.historichomeworks.com>.

Lee Valley Tools <http://www.leevalley.com>.

Log Home Store <http://www.aloghomestore.com>.

Marshalltown <http://www.marshalltown.com>. Masonry supplies.

Maze Nails <http://www.mazenails.com>. They still make cut nails.

McMaster-Carr <http://www.mcmaster.com>. They have both online and printed catalogs, but they only send printed copies to large purchasers. If you can't find one in your office or shop, try to get your purchasing or contracting officer—not just someone with a credit card, but someone with a lot of purchasing authority—to order one.

Olde Window Restorers <http://www.oldewindowrestorer.com>.

Rejuvenation <http://www.rejuvenation.com>.

Roofmaster Products Company <http://www.roofmaster.com>.

Schroeder Log Home Supply, Inc., <http://www.loghelp.com>.

Smith and Speed Mercantile <http://www.smithandspeed.com>.

System Three Resins, Inc., <http://www.systemthree.com>. When you order the catalog, also order the free epoxy book.

Traditional Woodworker <http://www.traditionalwoodworker.com>.

Woodcraft <http://www.woodcraft.com>.

Woodworker's Supply <http://www.woodworker.com>.

Magazines, Books, and Preservation Organizations

Audels Carpenters and Builders Guide, Numbers 1 through 4, and the **Audels Masons and Builders Guide**, Numbers 1 through 4. These publications are out of print, but easily can be found at used bookstores or online. Try to get an edition printed from the 1920s to the 1940s, with the dark brown cover.

Association for Preservation Technology <http://www.apti.org>.

Fine Woodworking <http://www.finewoodworking.com>.

National Trust for Historic Preservation <http://www.preservationnation.org>.

Old House Journal <http://www.oldhousejournal.com>.

Preservation Trades Network <http://ptn.org/>.

Timber Framer's Guild <http://www.tfguild.org>.

Traditional Building <http://www.traditional-building.com>.

Wood Magazine <http://www.woodmagazine.com>.

Woodsmith magazine, books, television show, etc., <http://www.woodsmith.com>.

Websites Mentioned in Other Sections of This Publication

Accessibility and historic preservation, National Park Service
<http://www.nps.gov/tps/how-to-preserve/briefs/32-accessibility.htm>

Accessibility standards, U.S. Access Board
<http://www.access-board.gov/guidelines-and-standards/buildings-and-sites>

Asbestos, Forest Service Facilities Toolbox
<http://www.fs.fed.us/eng/toolbox/haz/haz02.htm>

Asbestos, Occupational Safety and Health Administration
<http://www.osha.gov/SLTC/asbestos/index.html>

Axes, "An Ax to Grind"
<http://www.fs.fed.us/eng/php/library_card.php?p_num=9923 2823P>

Chain saw requirements, Forest Service Health and Safety Code Handbook 6709.11, part 22.48
<http://www.fs.fed.us/im/directives/fsh/6709.11/FSH6709.pdf> (starting at page 115)

Chain saw training, Chain Saw and Crosscut Saw Training Course materials
<http://fsweb.mtdc.wo.fs.fed.us/php/library_card.php?p_num=0667%202C01>
(available to Forest Service and Bureau of Land Management employees only)

Chimney liners, "Making Sense of Chimney Liners," Old House Journal
<http://www.oldhousejournal.com/chimney_liners/magazine/1465>

Colors, Federal Standard 595C color fan decks, other paint color matching products, and specifications <http://www.fed-std-595.com/>

Colors, "Finding the Original Colors of My House," Historic Media
<http://www.oldhousecolors.com/2007/01/18/finding-the-original-colors-of-my-house/>

Condition assessment, Forest Service
<http://fsweb.wo.fs.fed.us/eng/programs/facilities/assess.htm>
(available to Forest Service and Bureau of Land Management employees only)

Condition survey, "So That's Why It's Always Cold in Here: A Guide for Conducting Facilities Condition Assessment Surveys," Forest Service Technology and Development Centers
<http://fsweb.mtdc.wo.fs.fed.us/php/library_card.php?p_num=0473 2839>
(available to Forest Service and Bureau of Land Management employees only)

Confined space, Forest Service Safety Code Handbook 6709.11, part 38.2
<http://www.fs.fed.us/im/directives/fsh/6709.11/FSH6709.pdf>

Fiberboard, "Early 20th-Century Building Materials: Fiberboard and Plywood," Forest Service Technology and Development Centers
<http://fsweb.mtdc.wo.fs.fed.us/php/library_card.php?p_num=0773 2308>
(available to Forest Service and Bureau of Land Management employees only)

Fire, International Code Council fire and other codes
<http://www.iccsafe.org/>

Fire, International Wildland-Urban Interface Code
<http://publicecodes.cyberregs.com/icod/iwuic/2012/index.htm>

Fire, National Fire Protective Association fire code

<http://www.nfpa.org/freeaccess>

Hantavirus, Forest Service Facilities Toolbox

<http://www.fs.fed.us/eng/toolbox/haz/hanta.htm>

Hantavirus Job Hazard Analysis, Forest Service

<http://fsweb.r1.fs.fed.us/safetyhealth/jha/osha-h/JHA-hantavirus.doc>
(available to Forest Service and Bureau of Land Management employees only)

Hantavirus risk reduction, National Park Service

<http://www.nps.gov/public_health/zed/hanta/hanta_risk_redux.htm>

Hantavirus, Occupational Safety and Health Administration

<https://www.osha.gov/SLTC/hantavirus/>

Hazardous substances in buildings, Forest Service Facilities Toolbox

<http://www.fs.fed.us/eng/toolbox/haz/index.htm>

Historic facility sustainability, Forest Service Facilities Toolbox

<http://www.fs.fed.us/eng/toolbox/his/susbuildings.htm>

Historic facility sustainability, National Trust for Historic Preservation

<http://www.preservationnation.org/information-center/sustainable-communities/>

Historic facility sustainability, Whole Building Design Guide

<http://www.wbdg.org/resources/sustainable_hp.php>

Historic preservation, Guidelines for the Treatment of Historic Properties, National Park Service

<http://www.nps.gov/tps/standards.htm>

Historic preservation, Secretary of the Interior's Standards for the Treatment of Historic Properties, National Park Service

<http://www.nps.gov/tps/standards.htm>

Job Hazard Analysis examples, Forest Service

<http://fsweb.r1.fs.fed.us/safetyhealth/jha.htm>

Job Hazard Analysis examples, Northern Region Historic Preservation Team

<http://fsweb.r1.fs.fed.us/e/FacilitiesAndEnvironmental/HistoricPreservation/safety.htm>
(available to Forest Service and Bureau of Land Management employees only)

Lead and copper plumbing, Forest Service Facilities Toolbox

<http://www.fs.fed.us/eng/toolbox/haz/haz30.htm>

Lead-based paint, "Appropriate Methods for Reducing Lead-Paint Hazards in Historic Housing," Preservation Brief 37, The National Park Service

<http://www.nps.gov/tps/how-to-preserve/briefs/37-lead-paint-hazards.htm>

Lead-based paint, Forest Service Facilities Toolbox

<http://www.fs.fed.us/eng/toolbox/haz/haz03.htm>

Lead-based paint check kits and swabs, certified, Environmental Protection Agency

<http://www2.epa.gov/lead/epa-recognition-lead-test-kits>

Lead in construction, Occupational Safety and Health Administration
<https://www.osha.gov/Publications/osha3142.pdf>

Lead in renovation, repair, and painting, U.S. Environmental Protection Agency
<http://www2.epa.gov/lead/renovation-repair-and-painting-program>

Lead renovation, repair and painting program rule, U.S. Environmental Protection Agency
<http://www2.epa.gov/lead/lead-renovation-repair-and-painting-program-rules>

Lead roofing and flashing, Forest Service Facilities Toolbox
<http://www.fs.fed.us/eng/toolbox/haz/haz22.htm>

Levels, using
<http://www.engineersupply.com/How_to_Use_Berger_Transits_and_Levels.pdf>

Levels, and transits, using
<http://www.askthebuilder.com/using-transits-laser-levels-and-optical-builders-levels/>

Lockout and tag-out, Forest Service Safety Code Handbook 6709.11, part 38.3 (starting at page 240)
<http://www.fs.fed.us/im/directives/fsh/6709.11/FSH6709.pdf>

Log construction, "Building with Logs," Forest Service
<http://www.fs.fed.us/eng/facilities/documents/build_with_logs.pdf>

Mold, Centers for Disease Control and Prevention
<http://www.cdc.gov/mold/>

Mold, Environmental Protection Agency
<http://www.epa.gov/mold/moldresources.html>

Mold, Guide to Mold in the Workplace, Occupational Safety and Health Administration
<http://www.osha.gov/dts/shib/shib101003.html>

Mold, Occupational Safety and Health Administration
<https://www.osha.gov/SLTC/molds/>

Mold, "The Facts About Mold," American Industrial Hygiene Association
<http://www.aiha.org/about-ih/Pages/Facts-About-Mold.aspx>

Moss on roofs, "Care and Maintenance of Wood Shingle and Shake Roofs," Oregon State University
<http://owic.oregonstate.edu/sites/default/files/pubs/shake_roof_maintenance.pdf>

Moss removal, Oregon State University
<http://bryophytes.science.oregonstate.edu/page24.htm>

National Historic Preservation Act
<http://www.achp.gov/nhpa.html>

National Park Service Preservation Briefs
<http://www.nps.gov/tps/how-to-preserve/briefs.htm>

National Park Service Technical Preservation Services
<http://www.nps.gov/tps/index.htm>

National Register of Historic Places Program: Fundamentals
<http://www.nps.gov/nr/national_register_fundamentals.htm>

National Trust for Historic Preservation
<http://www.preservationnation.org>

Northern Region Historic Preservation Team
<http://fsweb.r1.fs.fed.us/e/FacilitiesAndEnvironmental/HistoricPreservation/include_home.htm>
(available to Forest Service and Bureau of Land Management employees only)

Paint, lead-based, Forest Service Facilities Toolbox
<http://www.fs.fed.us/eng/toolbox/haz/haz03.htm>

Paint, oil-based, Forest Service Facilities Toolbox
<http://www.fs.fed.us/eng/toolbox/haz/haz40.htm>

Paint steam removal process, John Leeke's Historic Homeworks
<http://www.historichomeworks.com/hhw/reports/reports.htm#steam>

Paint steam removal process, Olde Window Restorers Portable Steam Paint and Putty Stripper
<http://www.oldewindowrestorer.com/steamstripper.html>

Paint, "Why House Paint Fails," Forest Products Lab
<http://www.fpl.fs.fed.us/products/publications/specific_pub.php?posting_id=1024&header_id=p>

Preservatives, "Guide for Use of Wood Preservatives in Historic Structures," Forest Products Lab
<http://www.fpl.fs.fed.us/documnts/fplgtr/fpl_gtr217.pdf>

Preservatives, "Performance of Preservative-treated Wood Shingles and Shakes," Forest Products Lab
<http://www.fpl.fs.fed.us/products/publications/specific_pub.php?posting_id=15527>

Preservatives, "Preservative-Treated Wood and Alternative Products in the Forest Service," Forest Service Technology and Development Centers
<http://www.fs.fed.us/t-d/php/library_card.php?p_num=0677 2809P>

Resilient flooring, "Early 20th-Century Building Materials: Resilient Flooring," Forest Service Technology and Development Centers
<http://fsweb.mtdc.wo.fs.fed.us/php/library_card.php?p_num=0773 2322>
(available to Forest Service and Bureau of Land Management employees only)

Roofs, working on, Forest Service Safety Code Handbook 6709.11, part 33
<http://www.fs.fed.us/im/directives/fsh/6709.11/FSH6709.pdf> (starting at page 210)

Roofs, working on, Occupational Safety and Health Administration fall protection requirements
<https://www.osha.gov/doc/guidance.html>

Safety and historic preservation, Whole Building Design Guide
<http://www.wbdg.org/design/accommodate_needs.php>

Shakes, "The Froe and You: How to Make Hand-Split Shakes," Mother Earth News
<http://www.motherearthnews.com/diy/Wooden-Shingles-zmaz73ndzraw.aspx>

Shingles, "Performance of Preservative-Treated Wood Shingles and Shakes," Forest Products Lab

<http://www.fpl.fs.fed.us/products/publications/specific_pub.php?posting_id=15527>

Shingles, "The Repair and Replacement of Historic Wooden Shingle Roofs," National Park Service, Preservation Brief 19

<http://www.nps.gov/tps/how-to-preserve/briefs/19-wooden-shingle-roofs.htm>

Siding, "Early 20th-Century Building Materials: Siding and Roofing," Forest Service Technology and Development Centers

<http://www.fs.fed.us/eng/php/library_card.php?p_num=0873 2308P>

Split rings, design

<http://fabrication.clevelandsteel.com/Asset/Design_Man_Teco.pdf> (specific to one manufacturer)

State Historic Preservation Officers contact information

<http://www.ncshpo.org/shpodirectory.shtml>

Window energy efficiency, National Trust for Historic Preservation

<http://www.preservationnation.org/information-center/sustainable-communities/green-lab/saving-windows-saving-money/>.

Window restoration, City of San Antonio's Office of Historic Preservation

<http://www.sanantonio.gov/historic/Docs/Brochures/WindowRestorationWorkshop.pdf>

Wood-destroying insects, University of Florida

<http://www.edis.ifas.ufl.edu/IN035>

Wood stove, NFPA 211 "Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances," National Fire Protection Association

<http://www.nfpa.org/codes-and-standards/document-information-pages?mode=code&code=211>

Wood stoves, approved, Environmental Protection Agency

<http://www2.epa.gov/compliance/list-epa-certified-wood-stoves>

Wood stoves, classic, Vermont Castings

<http://www.vermontcastings.com/products/Stoves/Wood-Burning/>

Wood stoves, classic, Avalon

<http://www.avalonfirestyles.com/product-guide.aspx>

Wood stove installation and operation, National Agricultural Safety Database

<http://www.nasdonline.org/document/1254/d001052/wood-stove-installation-and-operation.html>

Wood stove installation and operation, University of Missouri extension office

<http://www.extension.missouri.edu/publications/DisplayPub.aspx?P=g1730>

Wood stove installation and operation, "Wood Stove Installation and Operation," University of Delaware Cooperative Extension

<http://nasdonline.org/1248/d001052/wood-stove-installation-and-operation.html>

Appendix H—Training Opportunities

Ninemile Wildlands Training Center

The Forest Service's Ninemile Wildlands Training Center <http://www.fs.usda.gov/detailfull/lolo/home/?cid=STELPRDB5085919&width=full> offers a variety of training courses. The Northern Region Historic Preservation Team teaches historic preservation classes through the Ninemile Training Center and offers classes almost every year in door and window construction, log repair and replacement, and cedar shingle roofing. Other classes offered include building mothballing techniques, paint and preparation techniques, porch rebuilding and repair, and preservation planning.

Northern Region Historic Preservation Team

The Northern Region's Historic Preservation Team has an excellent workshop and equipment. Every winter, they repair, rebuild, and replicate windows and doors in their shop while teaching other Forest Service employees to do the same (figures H1 and H2). They also conduct hands-on field training in all phases of restoration work during restoration projects on Forest Service and other Federal Government projects. Forest Service employees can contact the Northern Region Historic Preservation Team <http://fsweb.r1.fs.fed.us/e/FacilitiesAndEnvironmental/HistoricPreservation/training.htm> to arrange training, either in the shop or at a historic site (website available only to Forest Service and Bureau of Land Management employees) or at 406–329–3478.

Figure H1—These Forest Service employees use methods taught by team members at the Northern Region Historic Preservation Team workshop to rebuild windows for historic buildings on their units.

Figure H2—The Northern Region's Historic Preservation Team uses this window mock-up as a teaching tool in their workshop. Those learning how to build or rebuild a historic window can disassemble it to see all the parts, how they work, and how to reassemble them.

Passport in Time

Passport in Time (PIT) <http://www.passportintime.com> is a volunteer archaeology and historic preservation program of the Forest Service. PIT volunteers work with professional Forest Service archaeologists, historians, and preservation specialists to accomplish significant archaeology and preservation work, such as archaeological survey and excavation, restoration of rock art, archival research, restoration of historic structures, gathering oral history, and analysis and curation of artifacts.

Historic Preservation Training Center

The National Park Service's Historic Preservation Training Center <http://www.nps.gov/training/hptc/> offers training programs aimed at building the skills of personnel responsible for maintaining and preserving historic properties and also offers a 3-year training program for exhibit and preservation specialists.

Appendix I—Bibliography and Selected References

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The skilled craftsmen of the **Northern Region Historic Preservation Team** restore historic Federal buildings, often at remote sites, using traditional and modern technologies and materials. The team's projects often provide training opportunities for other Federal employees and the general public as part of the Forest Service's Passport in Time and Heritage Expeditions programs. Passport in Time and Heritage Expeditions are part of the Forest Service's Heritage Program that enables the public to explore the past on national forests.

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This publication is a practical guide for preserving historic log cabins. It explains the history and styles of log cabins, condition and historic assessments, preservation requirements, project planning, and safety. This guide contains a thorough explanation of hands-on aspects of log cabin preservation, such as jacking and cribbing, log repair and replacement, log notching, terminology, and chinking and daubing. Repairs to foundations, roofs, windows, doors, chimneys, and interiors also are covered, as are annual maintenance needs and appropriate tools.

Keywords: asphalt, assessment, cabins, chimney, chinking, composition, cribbing, crowns, daubing, doors, epoxy, fireplaces, fixtures, floors, flues, foundations, hazards, hewing, historic, inspect, jacks, logs, maintenance, materials, metal, notching, oil, paint, plumbing, preservation, purlins, rafters, rakers, repair, restoration, roofs, safety at work, shakes, sheathing, shingles, sills, sod, spandrels, splices, stains, stoves, styles, terms, tools, trusses, walls, windows, wiring, wood

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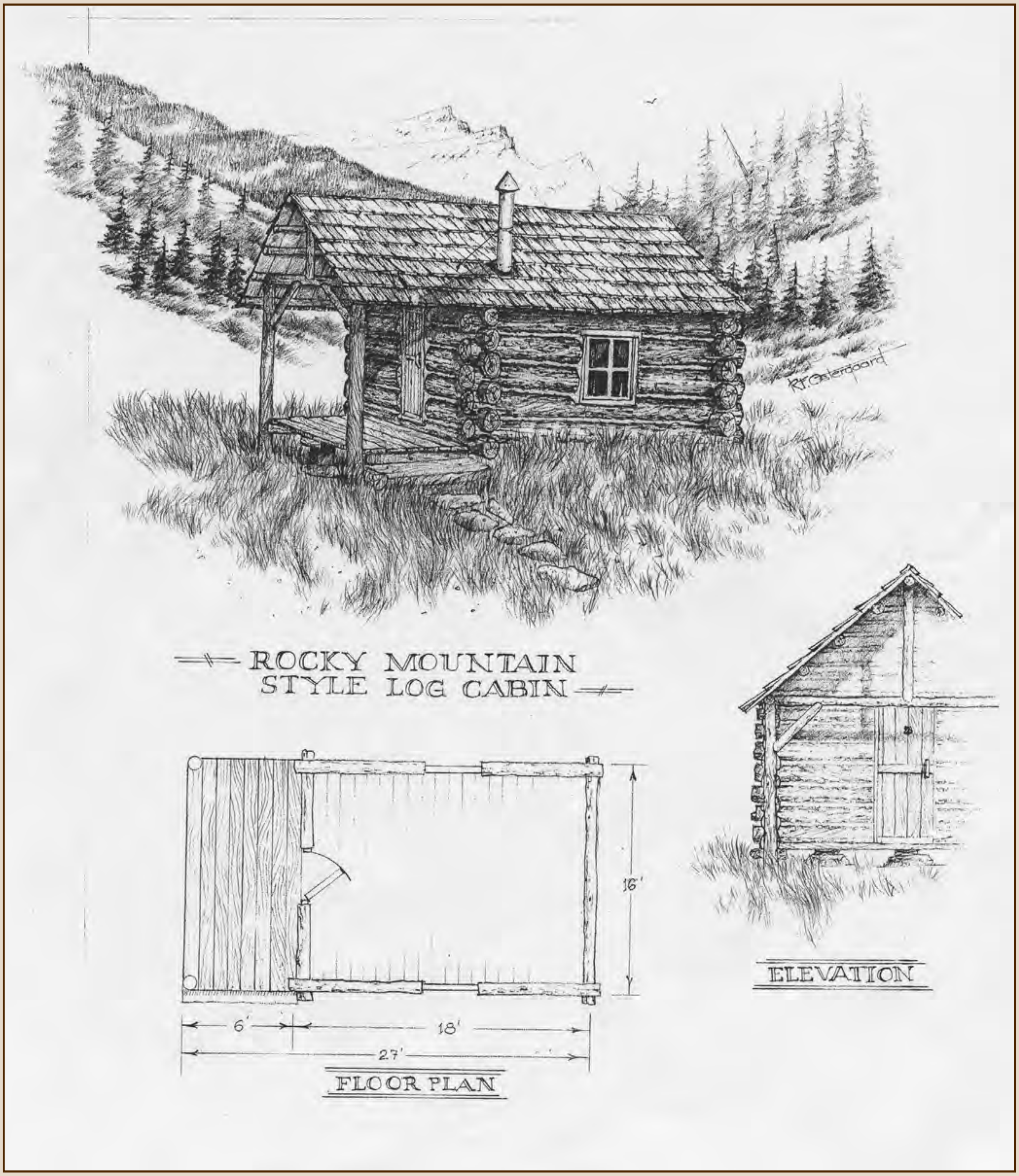

This drawing of a Rocky Mountain style log cabin was provided by Richard (Dick) F. Ostergaard (retired), a U.S. Department of Agriculture, Forest Service, landscape architect at the Rocky Mountain Region Center for Design and Interpretation and the San Juan National Forest.

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