Chapter 6
Retrofit

Should You Retrofit or Rebuild?

Log construction makes good economic sense in areas where there are local trees to cut and use. So does making the effort to rescue and rehabilitate our existing log structures since the cost to erect them has already been spent.

We call this cost "embodied energy." Embodied energy is all the manufacturing, shipping, and labor to build our homes the first time.

What is Payback?

Payback is all the money, work, and fuel that you save if you retrofit your house to become energy efficient.

It is usually true that if you have a log house that isn't rotting into the ground, it is probably worth retrofitting. This is especially true in remote communities of Alaska where shipping costs and heating fuel prices are very high.

Log building restoration projects may also be for historical or aesthetic reasons and not just for energy efficiency. Very old buildings may need many improvements to extend their life to reach their predicted payback time.

Retrofit Checklist

The following checklist is meant to guide you through the assessment process and to focus your efforts on areas needing improvement. Details on how to do some of the work follow.

Foundation and Floor Assessment

- ❑ Is foundation above the flood plain? Raise foundation elevation above high water mark.
- ❑ Is the floor level? Jack and level on existing foundation.
- ❑ Are foundation supports in good condition? Repair or replace pads/joists/plywood as necessary.
- ❑ Is foundation protected from moisture or wet soils? Raise floor joists at least 8 inches above ground—12 inches is even better. Install a capillary break between floor and foundation.
- ❑ Is the floor airtight without cracks and holes through the floor? Observe insulation installation at perimeter of floor below exterior walls and ensure the cavities are tight and full to minimize edge air intrusion. Air-seal at all floor penetrations, cracks, and perimeter

rim joists. Where space does not allow for working from below, airtight insulated skirting may be applied to the exterior of the rim joist area. Keeping the floor perimeter air tight is the key to comfortable and efficient floors. Do not interfere with the free flow of air under the house if it is built on permafrost.

- ❑ Does the floor insulation level meet the BEES R-value for the region (see Appendix A)? Add fiberglass or cellulose insulation between floor joists if space allows. Add rigid insulation to top of old floor with new plywood above where space does not allow placing fiberglass or cellulose in joist cavities.
- ❑ Is the insulation between the floor joists protected from critters? Sheath the bottom of the floor joists with plywood to support and protect insulation.

Log Wall Assessment

- ❑ Does air leak in between the sill log and the floor? Caulk and seal the perimeter sill log to the floor membrane inside the house.
- ❑ Does the floor protrude beyond the sill logs outside of the building? If so, this shelf area can allow moisture from rain and snow to enter the structure. Use a wedge of wood cut from 2-by-4 or 4x4 to fill this area and caulk the top and bottom to the sill log and floor or use metal flashing to protect the shelf from weather.
- ❑ Are the logs of sufficient size to provide adequate insulation for the region? Select a design for increasing wall R-value. Apply wall insulation and furring to the interior or exterior.
- ❑ Are joints between the logs tightly sealed and chinked against air leakage? Apply appropriate Weatherall/Perma-Chink type material to joints.
- ❑ Are the logs in good shape around window and door penetrations? Test logs with a probe to determine their condition. Replace or treat wood at penetrations to prevent further deterioration.
- ❑ Does air leak around windows and doors? Remove trim and inspect the gap between the rough opening and frame. Remove fiberglass chinking and install backer rod and fill cavity with minimally expanding foam if settling is over (older buildings). Air seal the perimeter of windows and doors between the frame and the rough opening.
- ❑ Are log wall corner joints tight and sealed against air leakage? Test log ends with probe and treat to prevent further deterioration. Air seal as necessary with caulks or chinking.
- ❑ Are the upper gable end wall purlin and ridge penetrations sound and air tight? Use a probe to ensure wood condition is adequate

for supporting the roof. Apply air sealing measures to penetrations and purlin and ridge pole ends. Treat logs in these areas as needed to prevent further wood deterioration.

Roof and Ceiling Assessment

- ❑ Does the roof overhang protect the log walls from rain? Extend the overhang at eaves to move drip line away from walls and corners. Install gutters and direct runoff away from the foundation area.
- ❑ Does the top log to ceiling/roof joint show signs of leaking or staining? Apply air sealing measures to eliminate leakage. Add insulation as needed to improve thermal properties at this connection. Use a probe to ensure wood condition is adequate for supporting the roof.
- ❑ Does the roof show signs of water staining or dry rot? Inspect and probe the wood around chimneys and light (electrical) penetrations. Inspect areas around interior wall connections with ceilings. If the house has a cold roof, turn over insulation batts to locate air leaking from below. These leaks will show as dark and dirty areas in fiberglass batts. Seal air leaks from the attic side using acoustical sealant and poly patches. Seal air leaks in hot roofs from the interior using appropriate sealants if no major exterior roof replacement is planned. Treat chimney penetrations with utmost care and concern for fire potential. Replace or reinforce all roof supports that show signs of rot or deterioration. Add insulation to cold roofs only after all other work has been completed. Maintaining an airtight roof and ceiling is critical to the success of any project.
- ❑ Does the roof exterior show signs of potential leak areas or weather damage? Replace or repair shingles and metal as needed to prevent water entry. Replace or repair the flashing around penetrations in roofing. Install eave flashing to "kick" water away from facia boards.
- ❑ Does the roof cover all log ends? Cut off all log ends that extend beyond the drip line of the roof.
- ❑ Finish interior and exterior of logs as recommended in Chapter 7.
- ❑ Remember, use all resources available to you to make your decisions regarding log retrofits. The AHFC Resource and Information Center has a library of information available at no charge (1-800-478-4636). The University of Alaska Cooperative Extension has an energy and building specialist on staff to answer your questions (474-7201 or 1-800-478-8324). These and other resources are listed at the end of Appendix D.

photo by Phil Loudon

A new roof in Arctic Village.

photo by Phil Loudon

The lower logs of buildings in ground contact will often be rotten beyond use and must be replaced.

So What Shape is Our House In?

Lower Log Condition

Check all lower logs for dry rot. The lower logs of buildings in ground contact will often be rotten beyond use and must be replaced. This can be a daunting task that requires digging, jacking, and sometimes rebuilding the floor-to-wall connection as the bottom few logs are replaced.

This may seem difficult, but it can help extend the life of a poorly insulated, energy-wasteful building 40 or 50 more years and save energy too. Where material and fuel transportation costs are high, this difficult job will still pay back good savings.

Looking for Rot Around Log Penetrations

Where air leaks occur in buildings, moisture will build up and cause rot. Inspect all mechanical and rough opening penetrations before making any decision to retrofit an existing log house. Use an awl, icepick, or a sharp knife point to probe the wood around any opening in the log walls. Where the wood is rotten the probe will go in easily. Areas of good wood will resist your efforts.

Usually, the lower openings will contain rot from outside moisture while the upper penetrations will rot from exposure to inside moisture. Because windows may let snow, rain, or ice collect on the exterior sills, be sure to probe the exterior logs in these areas.

If wood around a window opening is rotten, there are two common ways to fix it: Option one is to make the rough opening bigger if it is possible to cut out the rot and make a surface for reinstalling the window, and add foam insulation to fill in the gap.

Option two is to remove and replace the logs in the area of the opening. This is more expensive and so takes a longer time to pay back.

If two or more windows have severe rot and logs need to be removed, go back and look at the project budget very closely. The building may not be worth retrofitting.

This cabin was almost destroyed by rot.

Top Log Condition

The top log (cap log or plate log) is an area where air leaks open up over the years and moisture from indoors starts wood rot. When the temperature on the interior surface of the log drops, moisture will collect and possibly freeze on very cold days. This wetting, freezing, and drying cycle promotes rot.

Use the same probing method to find rot in the logs and framing. You should also check the joint between the ceiling and the wall for air tightness and insulation.

The cabin was saved by cutting out all four log corners and installing large vertical log corner posts. A good solution to use as much of the old building as possible. Note the trimmed roof logs and shorter porch.

One way to fix the top wall log to ceiling joint is by spraying several inches of a two-part urethane foam into the wedge formed by the wall and ceiling (see illustration, page 81). Then add a vapor barrier (usually polyethylene sealed with an acoustical sealant), and finally cover it with a nice trim board.

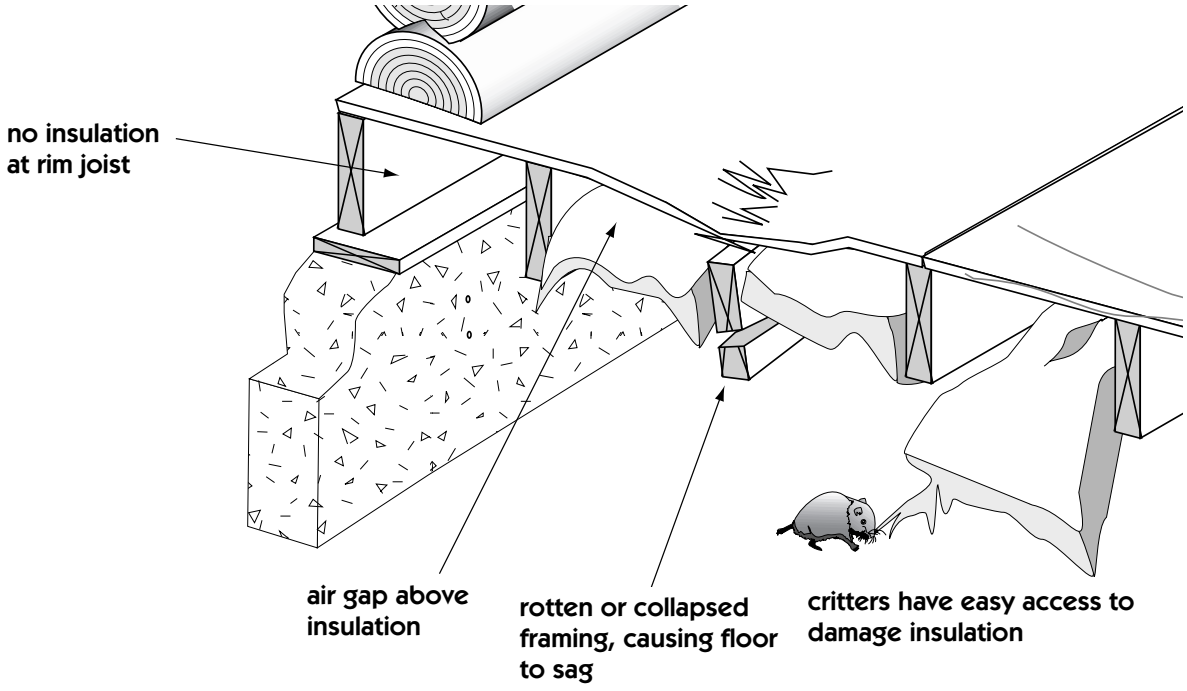
Let's Start at the Bottom

If you have enough room, a popular way to add insulation to the floor is to cover the existing floor with rigid foam, and cover this with plywood.

In many projects we have used two-inch extruded foam (usually blue, pink, or green) for the insulation overlay. This rigid insulation has a high compressive strength that makes it suitable for such installations. The covering plywood may be 3/4" tongue and groove. Use a structural adhesive and apply it to all plywood edges, including the tongue and groove, to construct an airtight floor membrane. Seal the joint between the perimeter plywood and the log wall with a durable polyurethane caulk. Drywall-type 3 1/2-inch screws are used to fasten the plywood through the foam, resulting in an additional R-10 insulation, an airtight floor, and a new durable surface for the finished flooring.

The negative associated with this approach is that rigid foam insulation is a higher cost per R-value insulation than "soft" insulations (fiberglass) and the

Some Problems to Look For



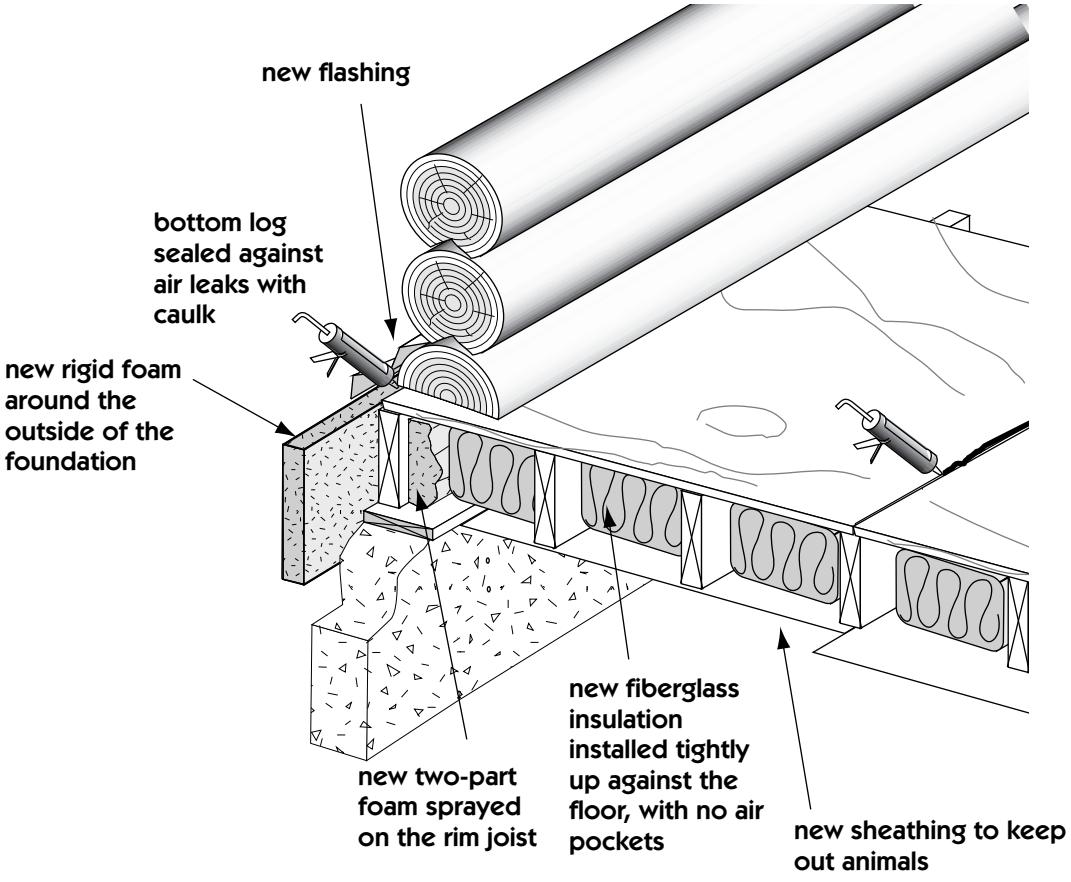
This floor is accessible and has floor joists that are deep enough for the minimum amount of insulation (see Chapter 3).

Observations from Arctic Village

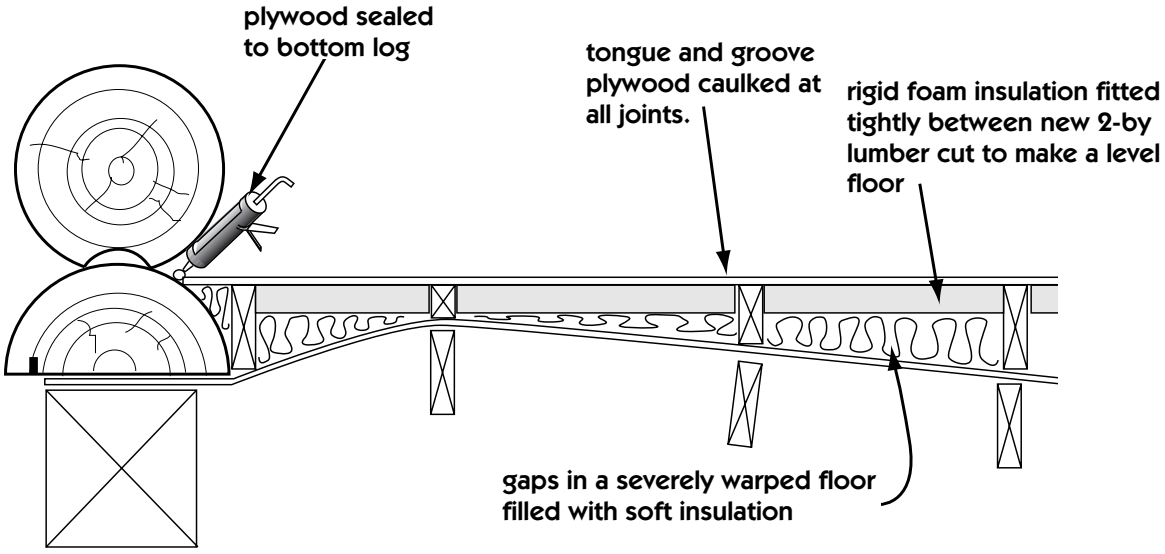
Sometimes, people cut logs in the spring and summer and then build with them in the fall. The logs may be only partially peeled or not peeled at all in some cases. When they build a house with logs like this, large cracks will develop in the logs after one year. First as the house is heated through the winter, the cracks will appear on the inside, and then the following summer as the sun heats the exterior, the cracks will appear on the outside. Eventually cold air will be able to travel completely through the cracks into the house, making the strucure very leaky.

Another problem that results is that the cracks and unpeeled areas will catch rain and snow, which will eventually rot the logs. This will speed up the process of failure of the bottom logs that are providing the foundation, which in turn will help to destroy the rest of the building. Homes that are built in this manner are falling apart much faster than they should.

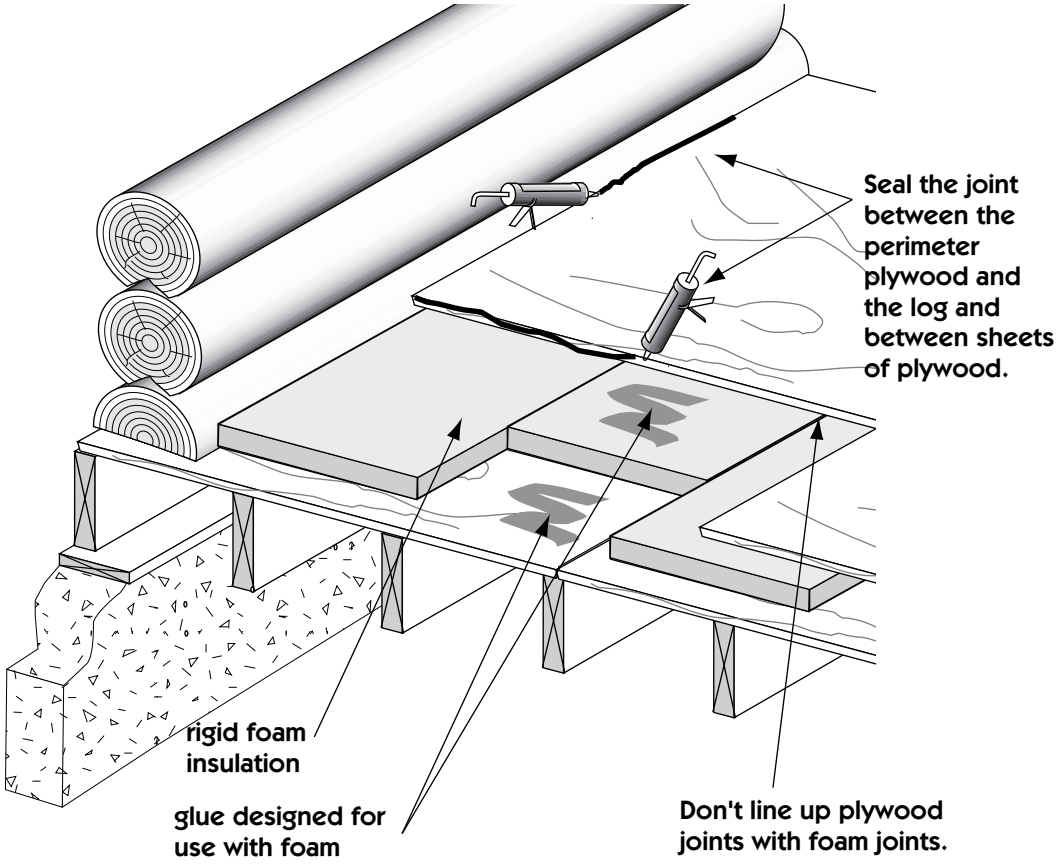
(comments from local resident, collected by Mimi Burbage)



A large part of the decision to fix the old floor and reinsulate or build up the floor from the inside of the house depends on whether you can even get under the house. It is usually more labor to go under the house and fix the old insulation, but the materials can be cheaper.



In spite of the insulation cost, it is less labor to install the insulation above the floor than working below the floor, framing additional cavities and making other labor-intensive modifications.



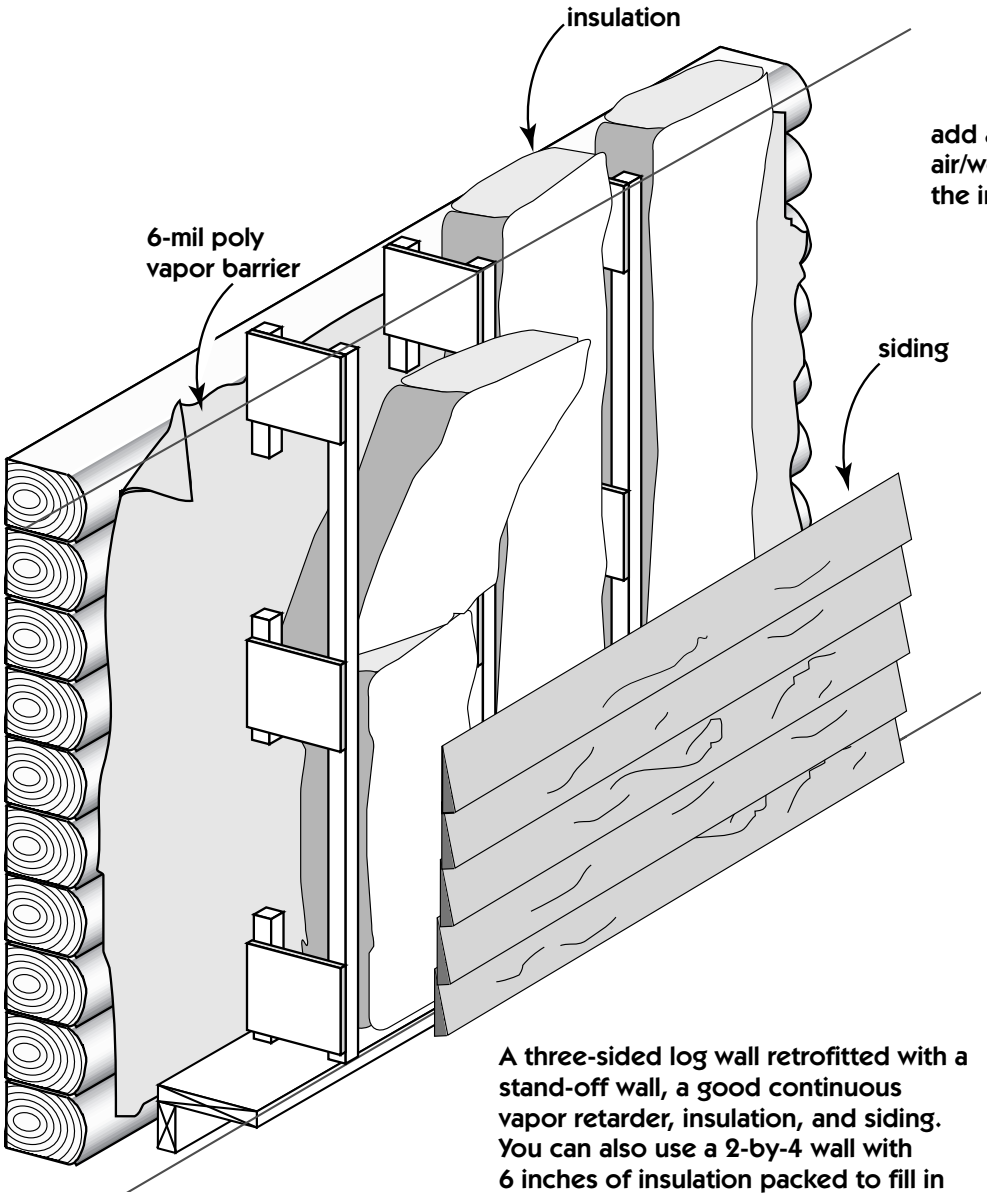
Here is an example of adding rigid foam to the top of the floor without any additional framing. Be sure to stagger the joints of the foam so they don't line up with the joints in the plywood.

added floor thickness of 2 3/4 inches makes adjustments to doorways necessary. However, in spite of the insulation cost, it is less labor to install the insulation above the floor than working below the floor, framing additional cavities and making other labor-intensive modifications.

Exterior Wall Retrofit

The most energy-efficient way to retrofit a log home is to attach an insulated curtain wall on the outside of the logs. This leaves the massive logs on the inside of the thermal envelope and provides very effective thermal storage. Once the logs are heated to room temperature, it may take days without heat for the logs inside the thermal envelope to cool off, even in an Alaskan winter.

An exterior retrofit of a log house typically involves chain sawing off the log extensions at all corners of the building. Do not compromise the structural integrity

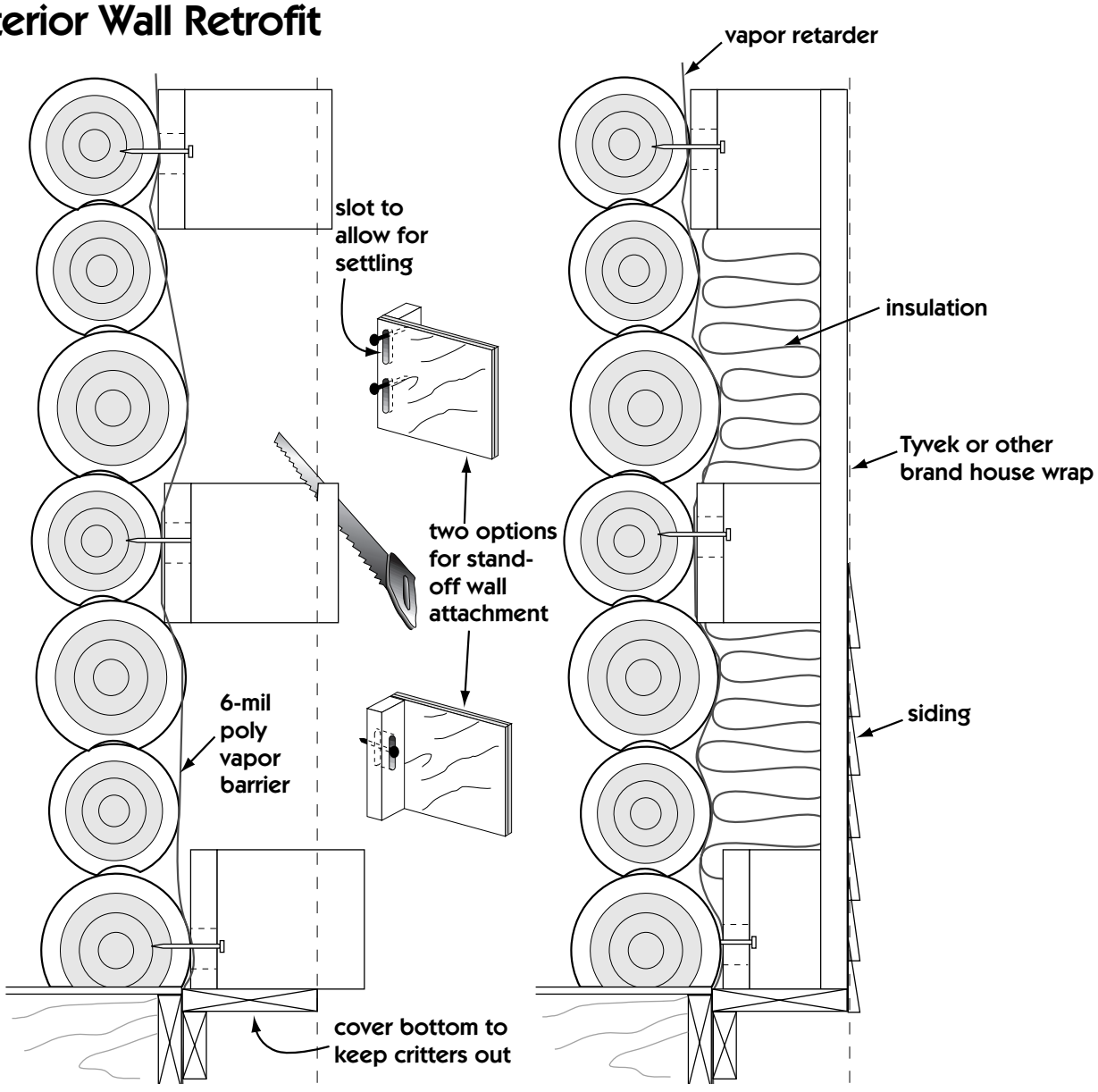


A three-sided log wall retrofitted with a stand-off wall, a good continuous vapor retarder, insulation, and siding. You can also use a 2-by-4 wall with 6 inches of insulation packed to fill in between uneven logs.

of the house by cutting off too much. The objective should be to remove any corner log ends that stick out beyond the curtain wall to be attached. Remove any other projections that would interfere with wrapping the exterior of the log walls with a continuous 6-mil poly vapor retarder. Pay particular attention to sealing the vapor retarder at the top and bottom and at all window, door, and utility penetrations.

Since log walls are irregular, it will be necessary to fit each stand-off stud with a system of blocking and plywood gussets attached to the logs on two-foot centers. First establish the corner stand-off studs plumb and at a distance from the log wall to accommodate the desired thickness of insulation. Use a string line pulled tight between the corner studs to establish the alignment of all the rest of the studs. Sometimes the roof rafters can support a hanging curtain wall. If the house has not completely settled (8 to 10 years in a dry climate), then be aware that the roof is still on its

Exterior Wall Retrofit



way down and attach the studs and the bottom plate in a manner that will allow for settlement.

It may be a good idea to wrap the insulated stand-off walls with a weather retarder house wrap such as Tyvek or Barricade before installing horizontal beveled or rough-cut spruce siding. The bottom of the wall should be covered with flashing, plywood, or dimensioned lumber to keep little creatures out.

Interior Wall Retrofit

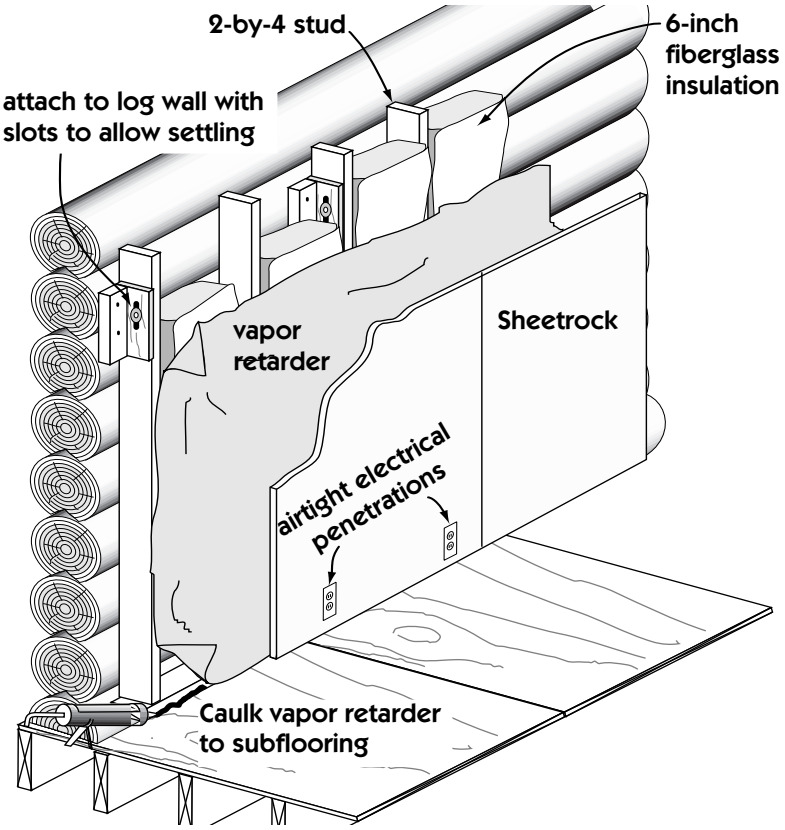
As stated in the introduction, an interior retrofit of a log home turns the logs into very heavy and expensive siding, with all the thermal mass on the outside of the thermal envelope. Nevertheless, it is very common to fur in, run electrical wiring, and insulate and vapor barrier walls constructed of small-diameter logs. This does indeed improve the thermal performance of the wall, not only by increasing the R-value but also by reducing the air leakage.

The interior retrofit also reduces space and can make a small cabin into a really small cabin.

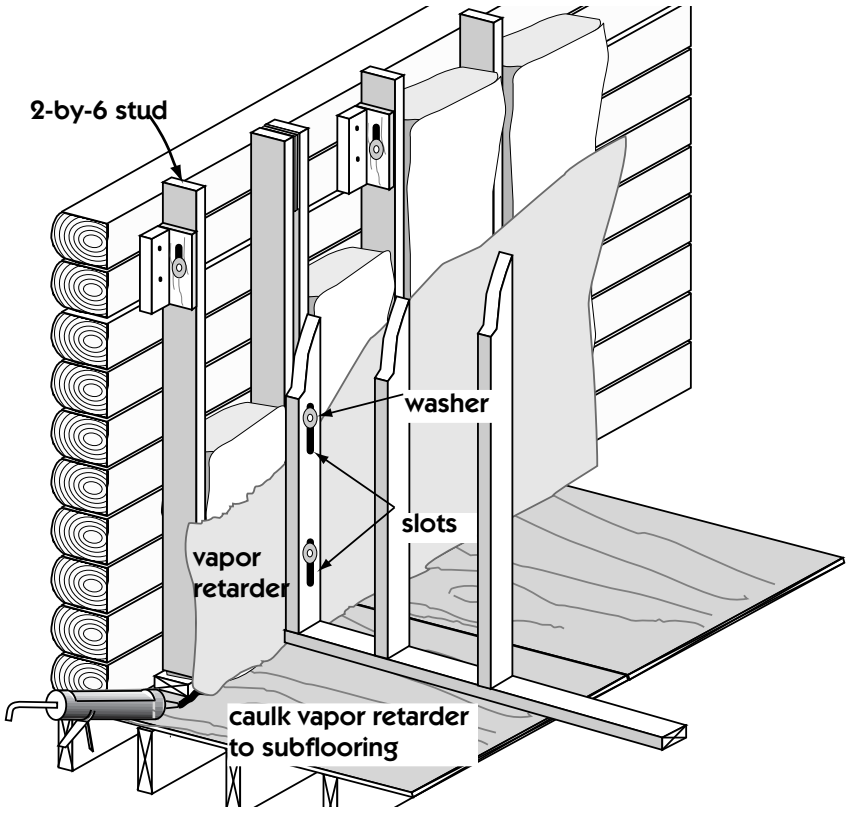
A simple way to add R-value to the inside without a lot of fastening problems is to use 2-by-4 studs and plates on the inside of the exterior walls. These should be installed tight to the logs and plumbed. Some shimming or shaving may be necessary to achieve a fairly straight wall, but this will depend on the quality of the original construction.

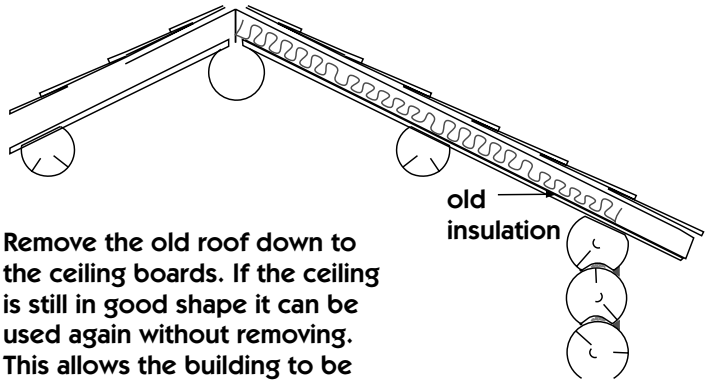
After the wall is fastened in place, use 6-inch fiberglass insula-

Interior retrofit on a log wall

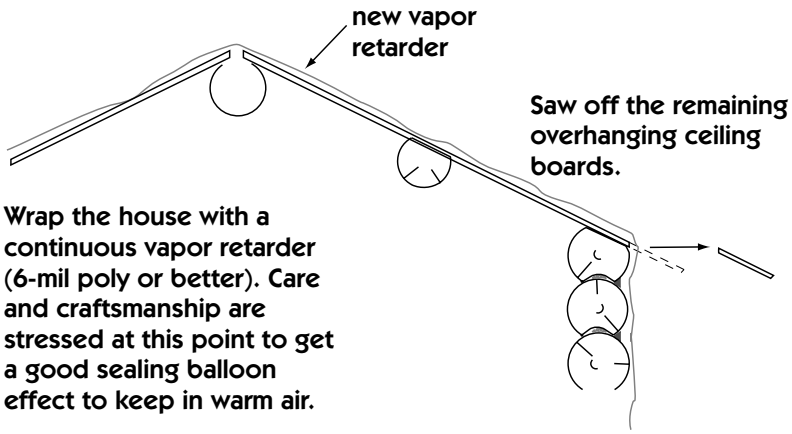


Attaching an interior wall to a three-sided log exterior wall with a 2-by-6



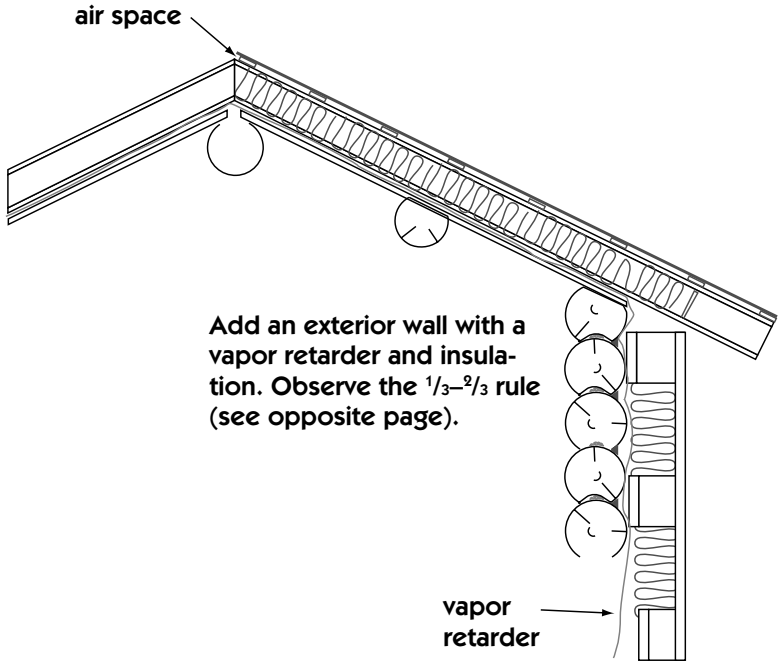


Remove the old roof down to the ceiling boards. If the ceiling is still in good shape it can be used again without removing. This allows the building to be occupied while the roof is being replaced.



Saw off the remaining overhanging ceiling boards.

Wrap the house with a continuous vapor retarder (6-mil poly or better). Care and craftsmanship are stressed at this point to get a good sealing balloon effect to keep in warm air.



Add an exterior wall with a vapor retarder and insulation. Observe the 1/3–2/3 rule (see opposite page).

tion and pack it into the stud cavities so that it fills the cracks between the logs and provides a good friction fit. Even though the insulation is compressed in some areas, it will still provide good insulating qualities since it will fill the voids adequately.

Install airtight electrical and mechanical outlets before installing the air-vapor barrier.

Roof Retrofit

If the finished ceiling is still in good shape but the roof is under-insulated or needs a vapor retarder, you may consider cutting off the eaves with a chain saw at the outside of the logs and running the new exterior wall vapor barrier of 6-mil poly up the wall and over the old roof and down the other wall. The gable-end wall vapor retarder should be caulked at the joint between the log and the ceiling as well as where the log meets the floor at the bottom of the wall. Lap over and seal the vapor retarder to the other sheets of poly at the four corners.

Place this exterior 6-mil polyethylene wrap on the warm side of the thermal envelope. Whether in the wall or roof system, at least two thirds of the R-value must be on the cold side of the vapor retarder to keep the humidity in the air warm enough so it doesn't condense into liquid water inside the wall or roof. Build up a new roof on top of the old, taking care to protect the vapor retarder during construction.

Hot Roof Retrofit

Hot roofs are typical in log buildings with traditional purlin and ridge pole exposed ceilings. Here the insulation is installed between the roof rafters. By definition, the hot roof does not provide ventilation. It usually has no access for installing additional insulation. Ventilated hot roofs are being constructed on newer log buildings, however, this is a recent development and it is rare to find such designs in older log cabins and houses.

You must first determine which surface to add the insulation to, inside or outside. If the roof consists of leaky shingles and rotten plywood, the obvious area to modify would be the outside. Strip off the shingles, install a vapor retarder, put insulation on the outside of the vapor retarder, and reinstall roofing.

The inside is a better approach because it is easier to get an airtight installation. Framing additional ceiling surface supports and insulating between the top log and purlin and between the purlin and ridge pole have proven successful, although this covers most of the log ceiling and may not appeal to some owners.

It is most important to locate the surface that will serve as the air barrier or vapor retarder if you put more insulation on the outside of a hot roof. If it will be the interior surface, great care must be taken to make it truly airtight, because if air leaks into the roof, the moisture carried in the air will damage the roof.

If you put a new air barrier on top of the existing roof, and more insulation and roofing above it, then the building science one-thirds/two-thirds rule must be rigidly adhered to. This rule helps you locate the air/vapor retarder in instances where the barrier might be placed between two insulation layers. If there is an air gap over the old insulation, pack the area above the outside walls to maintain a continuous blanket of insulation on all six sides of the house: four walls, floor, and roof.

> "At least two thirds or more of the R-value must be on the cold side of the vapor retarder. In the far north, at least three quarters should be on the cold side."

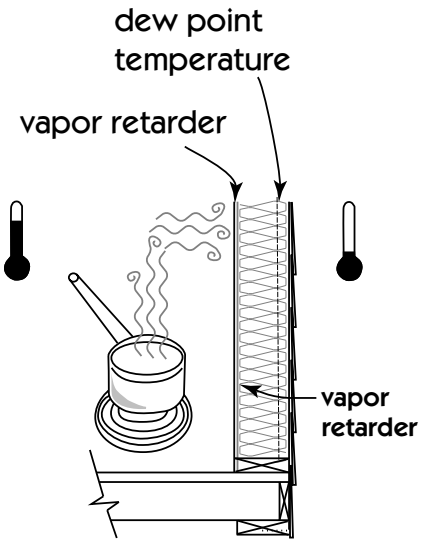
photo by Phil Loudon

An interior retrofit of a ceiling in progress; note new electrical wires being installed.

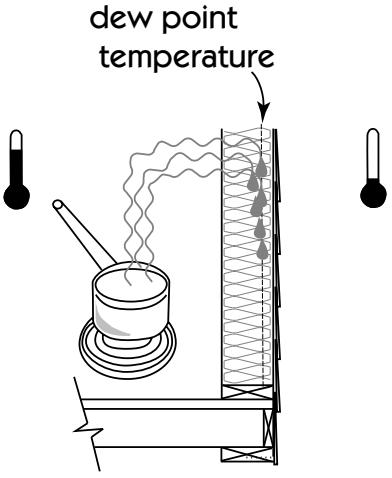
> Water vapor in the air gets cooler as it moves out through the wall and roof. If it condenses inside the wall of the house, it will cause rot.

What's a Dewpoint ?

The dewpoint is the temperature at which moisture condenses from vapor into water. Water vapor in the air in the house gets cooler as it moves out through the wall and roof, and at some point it condenses. If this temperature is inside the wall of the house, it will cause rot. This is why at least two-thirds of the R-value of your insulation must be outside of the vapor retarder. In the far north at least three quarters should be on the cold side.



vapor retarder stops moisture-laden air from entering wall space



moisture-laden air condenses inside wall, causing damage

Cold Roof Retrofit

We typically call a truss roof a cold roof because the space above the insulation is ventilated to the outside. While not always ventilated, this attic space is designed to be significantly colder than a hot roof, where ventilation space is minimal or nonexistent. The cold roof can receive more insulation since space is usually available.

Before putting more insulation in the attic, seal all ceiling and attic penetrations to prevent any air leakage from carrying moisture into the attic space. This is usually done from the attic (top) side by finding each leak and applying a heavy bead of acoustical sealant around the penetration and embedding a patch of polyethylene into the sealant. Tape this patch in place so it won't move around. Do this to all penetrations and breaks in the air/vapor barrier, including partition walls. This is not the place to skimp or save on acoustical sealant.

After all air sealing has been done, you should measure the distance between the outside edge of the wall and the underside of the roof plywood or metal. If room exists for meeting the minimum recommended BEES insulation, then proceed with putting new insulation in place. However, most older roofs don't have enough space to allow for high levels of insulation over the wall. Use a rigid insulation that has a high R-value per inch such as foamboard where space is tight. Cutting the rigid material to

fit tightly into the cavity is important! By placing three layers of two-inch polyisocyanurate rigid foam insulation (R-48), you can come closer to meeting the minimum recommended BEES standards than would be possible using soft insulations (fiberglass) in this tight space over the wall.

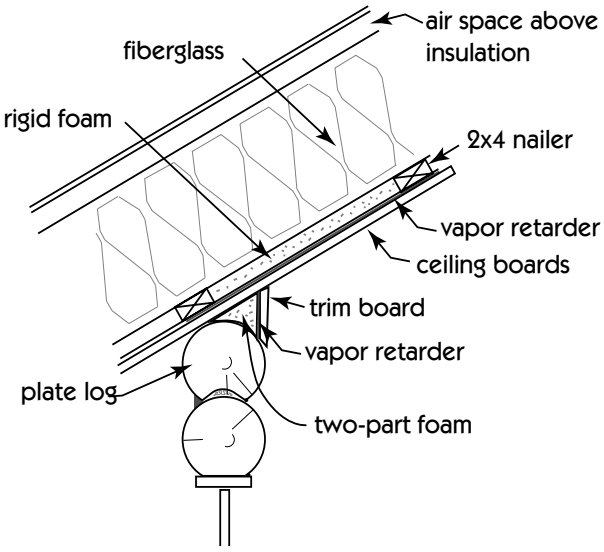
Chimney and Flue Penetrations

This is an area of frequent failure in all types of roofing. There are two potential problems: chimneys located too close to wood are a fire hazard, and leaks can develop in the roof around chimney penetrations, leading to rot.

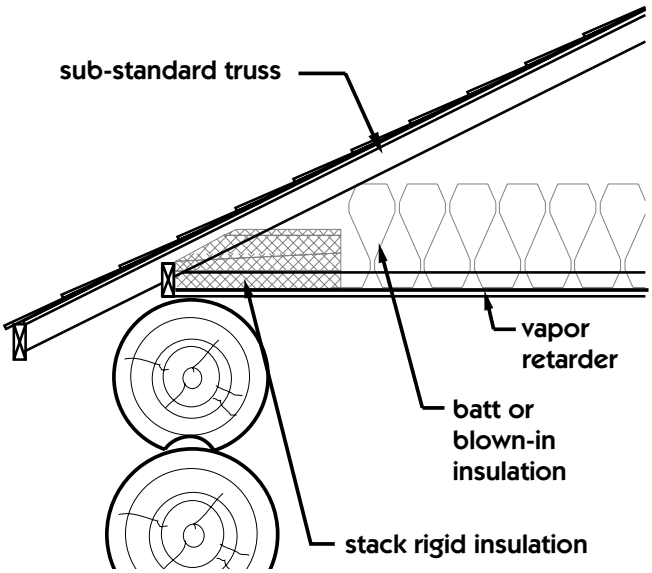
Research has shown that where heating appliances are near wood, a significant drop in the wood ignition temperature occurs. It will ignite and burn easily at much lower temperatures.

Maintaining a good air gap around the insulated pipe above the ceiling is also necessary, and more is better here. If the attic contains lots of insulation, you should extend the insulation dam (a sheet-metal cylinder around the chimney) to prevent insulation from getting into the air gap surrounding the chimney. The dam should always be left open at the top to allow air currents to cool the space between the dam and chimney. Always follow the manufacturer's instructions. Just following codes and regulations may not be enough to prevent the wood framing from turning into fuel.

Chimneys typically found in older buildings must be improved



One way to fix the joint between the top wall log and the ceiling is by spraying several inches of a two-part urethane foam into the wedge formed by the wall and ceiling. Then add a vapor barrier (usually polyethylene sealed with an acoustical sealant), and finally cover it with a nice trim board.

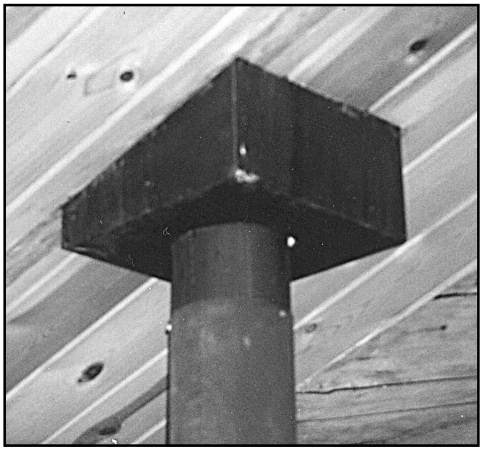


rigid foam in truss-style roof with attic

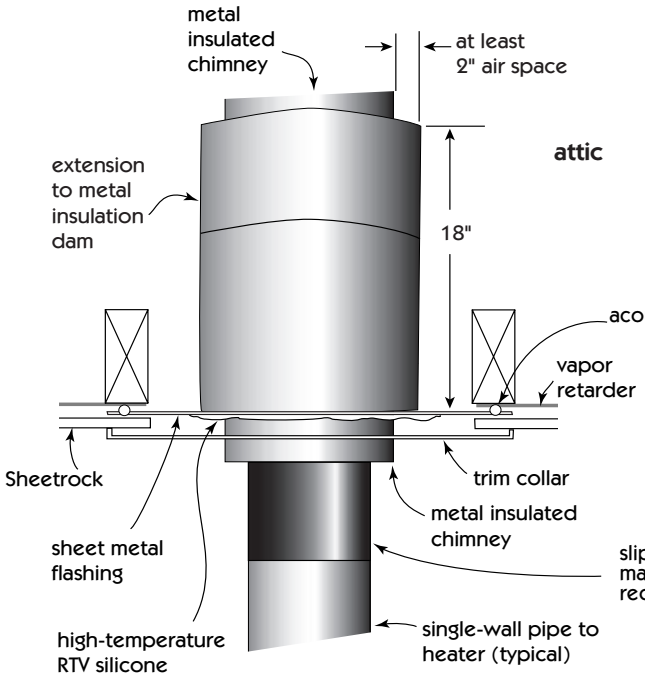
to prevent moisture from entering framing members in the roof and ceiling. Therefore, care must be taken to eliminate all air leakage around chimneys. See the illustrations for examples of how to do this safely.

Note that different caulks and sealants are used to provide for a complete and airtight seal around the chimney and to the surrounding drywall. Use a high-temperature heat rated RTV silicone caulk for air-sealing the trim ring to the insulated chimney.

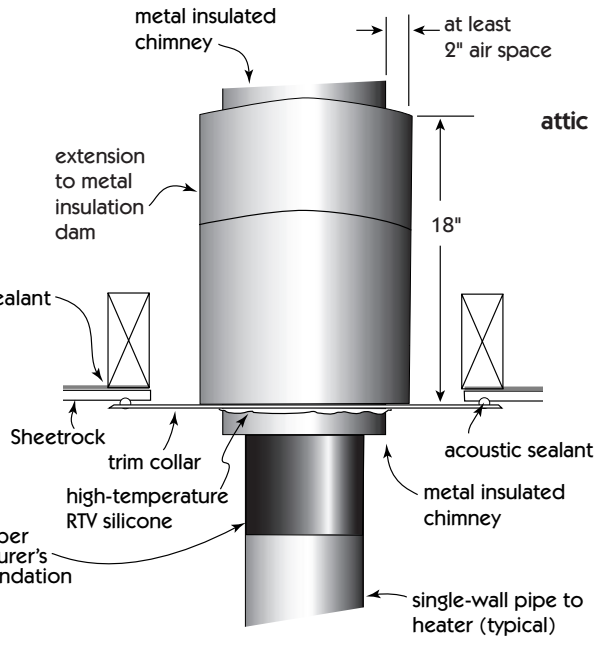
This stove pipe and chimney are overdue for a good safety upgrade and retrofit.



This is an example of a proper installation of a chimney and stove pipe.



Attic side air seal (typical on new construction)



Interior side air seal (typical on retrofit)