5.3 Wall Insulation

SWS Detail: 4.0201 Accessible Walls; 4.0202 Enclosed Walls

Install wall-cavity insulation with a uniform coverage and density. Wall cavities encourage airflow like chimneys do. Convection currents or air leakage can significantly reduce wall insulation's thermal resistance if channels remain for air to migrate or convect.

Important: Provide the client with an insulation receipt or certificate, with the insulation type and number of bags installed, installed thickness, coverage area, and insulation R-value. *See "Insulation Receipt or Certificate" on page 104.*

Blown Wall-Insulation Types

Cellulose, fiberglass, and open-cell polyurethane foam are the leading insulation products for retrofit-installation into walls.

Table 5-1: Wall Insulation Density and R-Value per Inch

Insulation Material	Density	R-Value/in.
Fiberglass (virgin fiber)	2.2 pcf	4.1
Cellulose	3.5 pcf	3.4
Open-cell urethane foam	0.5 pcf	3.8

pcf = pounds per cubic foot

5.3.1 Wall Insulation: Preparation and Follow-up

SWS Detail:4.0201 Accessible Walls; 4.0202 Enclosed Walls

Inspect and repair walls thoroughly to avoid damaging the walls, blowing insulation into unwanted areas, or creating a dust hazard.

Preparing for Wall Insulation

Before starting to blow insulation into walls, take the following preparatory steps.

- ✓ Calculate how many bags of insulation are needed to achieve the R-value specified on the bag's label.
- ✓ Inspect walls for evidence of moisture damage. If an inspection of the siding, sheathing, or interior wall finish shows a moisture problem, don't install sidewall insulation until the moisture problem is identified and solved.
- ✓ Inspect indoor surfaces of exterior walls to assure that they are strong enough to withstand the force of insulation blowing. Reinforce interior sheeting as necessary.
- ✓ Inspect for interior openings or cavities through which insulation may escape. Examples include balloon-framing openings in the attic or crawl space, pocket doors, unbacked cabinets, interior soffits, and openings around pipes under sinks and closets. Seal these openings with airtight, rigid, blocking material to prevent insulation from escaping the wall cavity.
- ✓ Verify that exterior wall cavities aren't used as return or supply ducts. Either avoid insulating these cavities, or remove the ducts and reinstall them somewhere else.
- ✓ Verify that electrical circuits inside the walls aren't overloaded. Maximum ampacity for 14-gauge copper wire is 15 amps and for 12-gauge copper wire is 20 amps.
- ✓ Perform a voltage-drop test to evaluate the size and condition of hidden wiring on older homes. Use a "Sure Test Branch Circuit Analyzer", or similar device that measures the voltage drop at full load (15 amps). Voltage drop may not exceed 5%.
- ✓ Install S-type fuses to prevent circuit overloading if necessary.

- ✓ Don't insulate cavities containing unshielded high-temperature devices — chimneys, flues, vents, wall heaters —unless they are zero clearance devices or unless you can maintain the required clearance.
- ✓ Don't insulate cavities containing knob-and-tube wiring.
- ✓ Prepare documentation of the insulation type, installed thickness, coverage area, and insulation R-value to post near the electrical service panel after installation.

Balloon-framed gable wall insulation: Spray foam plug or other rigid dam prevents insulation from escaping the wall cavity. The dam also prevents air circulation or wind washing through wall insulation.

Patching and Finish after Insulating

The insulators, the home owner, and others should agree about the patching method and the final appearance of the wall finish. The insulators are usually responsible for patching holes and returning the interior or exterior finish to its previous condition or some pre-agreed level of finish. See upcoming sections on various wall finishes for instruction on re-installation and patching.

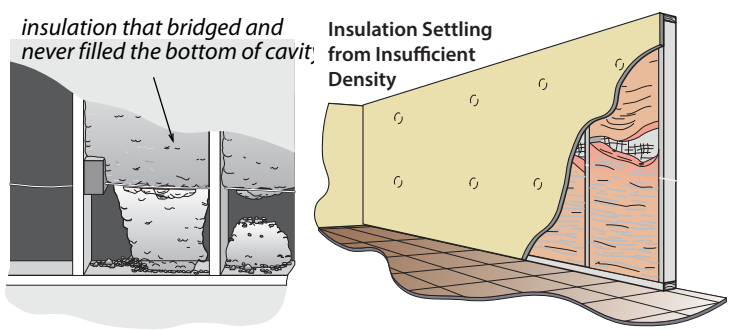
- ✓ Plug all holes that were drilled underneath the siding with tight fitting wood or foam plugs. Use foam, tar paper, or ice and water shield (the best alternative) to restore the walls' water-tight condition.

- ✓ Use caulk or putty and primer to dress exposed exterior plugs.
- ✓ Seal gaps in external window trim and other areas that may admit rain water into the wall.
- ✓ Patch interior finish with standard plastering methods or a chair rail trim board.
- ✓ Install drywall with joint compound to open cavities to comply with IRC fire codes.

Wall Insulation Quality Control

Retrofit wall insulation has more risk of incomplete application than insulation that you can visually inspect. Consider these quality control options to verify the proper coverage and density of retrofit wall insulation.

- Viewing the wall through an infrared camera.
- Looking through an electrical outlet or other access hole for insulation.
- Calculation of installed weight of installed insulation compared to wall-cavity volume and required density.



Problems with low density insulation: Blowing insulation through one or two small holes usually creates voids inside the wall cavity. This is because insulation won't reliably blow at an adequate density more than about one foot from the nozzle. Use tube-filling methods whenever possible, using a 1.5-inch hose inserted through a 2-inch or larger hole.

5.3.2 Retrofit Closed-Cavity Wall Insulation

SWS Detail:4.0202.1 Dense Pack Insulation; 4.0201.3 Dense Pack Insulation; 4.0202.6 SPF Insulation Installation in Closed Cavities

This section describes two ways of installing wall insulation.

1. Blowing walls with fibrous insulation using a fill tube from indoors or outdoors.
2. Injecting liquid foam into a closed wall cavity.

5.3.3 Accessing Wall Cavities

Mistakes are most common at the beginning of any job. For the sake of appearances, start on the least important part of the house — facing the backyard or another nearby building.

For frame walls with lap siding, remove a row that is between one and 2 feet above the bottom plate for both convenience and to avoid blowing both up and down. Be prepared to patch or replace siding if necessary, depending on your evaluation of its current condition and its difficulty to remove.

Lath and Plaster or Drywall

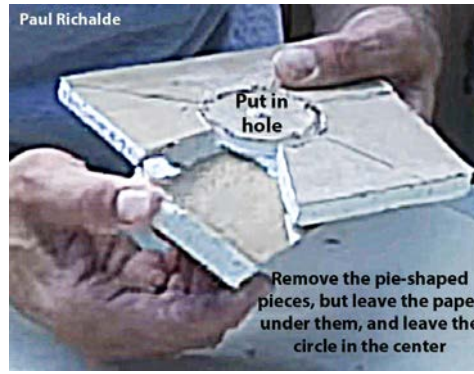
If you drill indoors through lath and plaster, use a carbide tip hole saw at least 2 ½ inches in diameter. Assume lead paint if you're not testing, and follow lead-safe precautions carefully.

A butterfly patch, also known as a California patch is probably the best type of patch.The butterfly patch is a piece of drywall with the same size plug as the hole you drilled, surrounded by a larger piece of drywall paper.

Or, patch the hole with a stiff joint compound as a base and standard joint compound as finish. The stiff joint compounds are very difficult to sand, if their surface rises even $^{1}/_{32}$ inch above the surface of the finished wall, so keep the first layer well below the surface and top the patch off with standard sand-able joint compound.

You can also install a primed and painted trim board horizontally to cover all the holes.

The butterfly patch: Drywall paper surrounds the circular drywall plug. The paper makes finishing the patch easier and faster. Make a supply of these before starting a job.



Wood Lap Siding

Wood siding can be difficult to remove and replace without damage, especially if it has several coats of intact paint. Old painted wood can be very brittle and it's paint very fragile.

- ✓ Consider the possibility that you may break or split pieces of siding and may need some new siding to replace damaged pieces.
- ✓ Choose a piece of lap siding a comfortable height one or two feet above the bottom plate. To begin, cut your chosen piece of lap siding vertically at the vertical corner trim so that you can remove it after pulling the nails.
- ✓ Use a utility knife or a sharpened putty knife to cut completely through the paint at the bottom of your chosen piece of siding.
- ✓ Pull the nails on the bottom edge of your chosen piece. A ram type nail puller creates less damage to the wood compared to a bar-type nail puller. Or you can lift the siding slightly directly under each nail with a flat bar, and remove the nail.
- ✓ Use a nail punch to drive nails through the siding if you can't pull the nails.

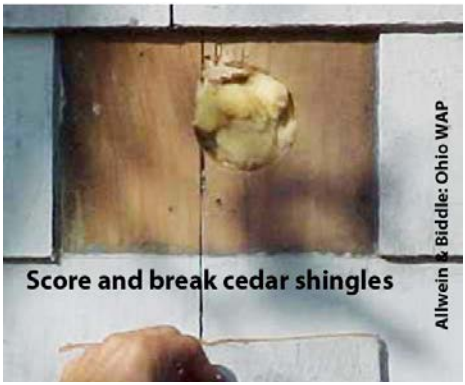
- ✓ After blowing, line up the siding in its original position. Nail the siding back in place using a new hole close to the old one, in order to catch the stud. Don't use the old hole because it may be too large to hold the new nail. Drill holes if you must to avoid splitting the wood.
- ✓ Use galvanized nails, and fill the damage at the nail holes with exterior caulking. Afterwards prime and paint as necessary.

The last resort: When you can't find an easier way, cut horizontally the piece you want to remove. Re-install it after you insulate, and face-nail it in place.

Wood Shingle Siding

First, identify the stud layout in the wall so you know which shingles to remove.

- ✓ Cut the paint on each vertical side of the shingle.
- ✓ Pry the single loose, and pull it down to remove it.
- ✓ Or score the shingle and break it to drill a hole, then face-nail it back in place.
- ✓ Replace the single by pushing it up to the shingle above it, and face nail it with a galvanized box nail.



Score and break a shingle: If the shingles are flexible, you may be able to remove nails. However, usually you must score and break the shingle, and then later face-nail it back in place.

Asbestos-Slate Siding

The individual slates of asbestos siding can be easy or difficult to remove depending on whether they are single-nailed or double-nailed and also on the amount of paint that covers them.

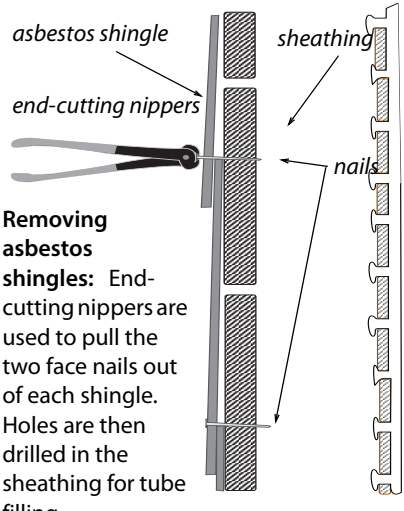
Be sure that you spray water on each slate, before trying to remove it. **The slate should be adequately wetted before you remove the slate, whole and intact.**

If the slate is only nailed at the bottom, you can pull the nails and slide it out. You may have to cut the paint around the slate with utility knife before removing it.

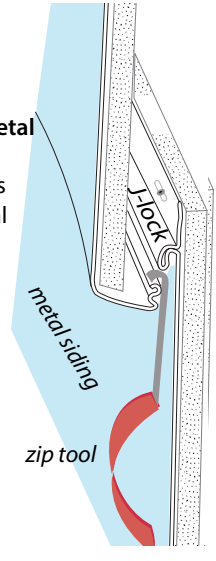
Ideally, you should have a supply of asbestos slates, in case you break a slate. The standard slate size is 12 by 24 inches, and you can buy them in 18-slate bundles online, if you can't find them locally. The slates come in several different designs.

Removing or Cutting the Nails: Open a pair of end nippers a little wider than the head of the nail. Center the nail between the jaws of the nipper and press lightly. Hopefully, pressing the slate moves the slate inward allowing the nipper blades to squeeze under the nail head. Pull on the nail, but don't use the slate for leverage. Try turning the nail clockwise and counterclockwise with the end nippers. Don't move the nail back-and-forth because this might break the fragile slate. If the nail won't come out, try cutting the head off with the end nippers.

Cutting Slates: Only If Necessary: Never cut asbestos slates with a saw. Dampen the area of the slate that you'll cut. While the slate sits on a solid surface, score the it with a scoring knife on both sides. Then, align the scored line with the straight edge of the supporting surface, and carefully break the slate along the scored line.



Removing asbestos shingles: End-cutting nippers are used to pull the two face nails out of each shingle. Holes are then drilled in the sheathing for tube filling.



Removing metal siding: A zip tool separates joints in metal siding.

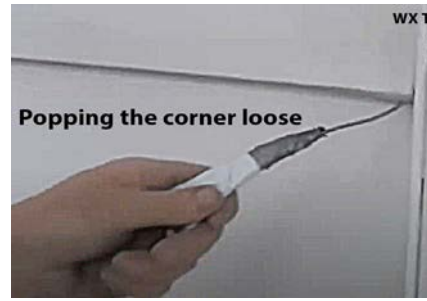
Metal Lap Siding

Metal siding can be easy or difficult to remove. Steel siding is typically more difficult than aluminum siding. Sometimes you're lucky and a zip tool separates the upper piece of siding from the J lock of the siding piece below it.

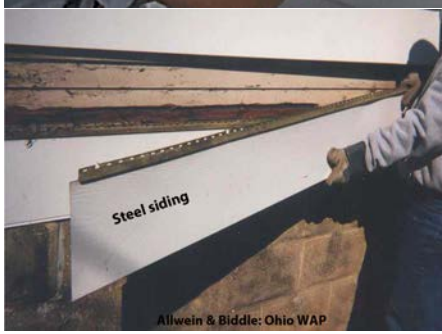
- ✓ Start at a corner or a joint, and pry the end of the J lock apart. Start there to unzip the two pieces of siding with the zip tool.
- ✓ Failing that, some installers use a piece of vinyl clothesline with a knot in the end. They insert the clothesline in the space between the siding and the J-lock at one end, and pull the clothesline toward the other end to unzip the joint.

- √ Still other installers, use a putty knife and a small flat bar to separate the joint. Others use a hook to separate the J-lock joint at an end or where two pieces of siding join one another.
- √ If you can't separate the joint through any of these methods, you can cut the lower piece of siding horizontally and remove it or bend it downward to drill your holes for the fill tube.

Pop the corner loose: Use a homemade tool, like this one, or a zip tool.



Lift the upper piece: Remove the nails that you expose from the piece below the one you unzipped.



Remove the lower piece: Then drill holes for the insulation.

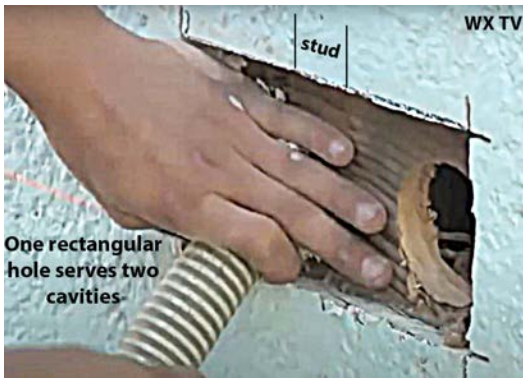
Vinyl Lap Siding

Vinyl siding is usually the easiest type of siding to remove. On most jobs, an installer simply unzips the joint with a zip tool. Start unzipping at a corner or a joint between two pieces.

Stucco Siding

First, identify the stud layout in the wall accurately so you know where to cut a hole in the stucco.

- ✓ Cut a 4-inch by 8-inch rectangular hole centered on a stud. This hole gives you access to two stud cavities and leaves you with half as many holes to patch.
- ✓ Pry wire lath open with side nippers or pliers, and remove it.
- ✓ After blowing the wall, stuff the hole with the tuft of fiberglass batt.
- ✓ Place tar-paper patches over the holes you drilled. Then install a rectangular piece of new lath.
- ✓ Apply two coats of stucco. Match the texture with the brush or sponge.



One hole fills two cavities: Use a pattern to mark the rectangular hole.

Masonite Lap Siding

Masonite lap siding is fragile and difficult to pry off its nails.

1. Instead just drive nail heads through the siding with the nail punch to remove it.
2. Fill the nail holes with a paintable caulk or spackle after you insulate.

5.3.4 Blowing Walls with a Fill-Tube

Install dense-pack wall insulation using a blower equipped with separate controls for air and material feed.

Select insulation that has a flame spread and smoke development index of 25/450 or less.

About Fill Tubes

Use a clear vinyl with $^1/_8$ inch wall thickness, 1 ¼ inch ID with a 2-inch x $1^1/_4$-inch reducer.

Cut a 45° angle at the tip to steer the tube around obstacles. The angle of the tip should align with the natural curvature of the tube.

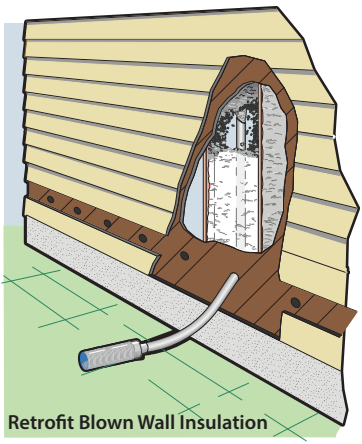
Insulation suppliers provide tubes for summer blowing and winter blowing. The summer blowing tubes are stiffer, and the winter blowing tubes are more flexible. The ideal is flexible enough to avoid obstacles and stiff enough so you can push the tube up to the top of the wall.

Straighten the tube with a heat gun if it's too curvy.

Accessories for dense-packing walls: Includes blower hose, 2 types of fill tubes. reducers, and clamps.

Use at least 50 feet of hose between the blowing machine and the fill tube. For example, connect 25 feet of 3-inch hose then a 3-to-2 ½-inch reducer. Next connect 15 feet of 2 ½-inch hose and a 2½-to-2-inch reducer. Next attach 10 feet of 2-inch hose and a 2-inch to 1 ¼-inch reducer to attach the fill tube. This type of stepped-down hose assembly conditions the insulation into a fast flowing aerated stream that distributes and packs the insulation but isn't likely to plug the hose.

Mark the tube with electricians tape or a black permanent marker, 12 inches from the tip of the angle and 8 feet from the tip of the angle. Those two marks tell you when the tube reaches the top of the cavity and when it approaches the bottom. You may be able to feel the tube hit the top plate, when you push it all the way in.



Tube-filling walls: perform this method indoors or outdoors. Tube-filling is the preferred wall-insulation method because it achieves a uniform coverage and density.

To prevent settling, blow dry cellulose insulation to 100% coverage and a density of at least 3.5 pounds per cubic foot (pcf). The fiberglass material must be designed for dense-pack installation and must reach at least 2.2 pcf.

Insulate walls using this procedure.

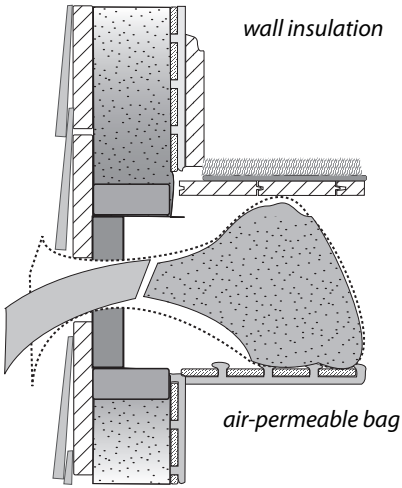
1. Drill 2-to-3-inch diameter holes to access the stud cavities.
2. Probe all wall cavities through these holes, before you begin insulating, to identify fire blocking, diagonal bracing, and other obstacles.
3. Start with several full-height, unobstructed wall cavities so you can measure the insulation density and adjust the blower. An 8-foot cavity (2-by-4 on 16-inch centers) should consume a minimum of 10 pounds of cellulose or 6 pounds of fiberglass.
4. Insert the hose all the way to the top of the cavity. Start the machine, and back the tube out slowly as the cavity fills.
5. Then fill the bottom of the cavity in the same way.
6. After probing and filling, drill whatever additional holes are necessary for complete coverage. For example: above windows or missed areas with fire blocking.
7. Use the blower's remote to control air and feed separately in order to achieve a dense pack near the hole while limiting spillage.
8. Plug the holes with tufts of fiberglass batt, repair the weather barrier at each hole, and re-install the siding.

Insulating the Wall-Floor Junction of Two-Story Walls

When insulating the perimeter of walls between the first and second floors, blow an insulation plug into the perimeter floor cavities for both thermal resistance and airflow resistance.

This method is effective for both balloon-framed and platform-framed walls. With platform-framed walls, the wall insulation is discontinuous at the floor cavity unless you drill and blow through the rim joist there. With balloon-framed walls, there is a gaping hole at the second floor and no rim joist

This dense-packed plug prevents the second-floor cavity from acting as a thermal bridge and an air-leakage pathway. Using a fill tube, blow the insulation into a air-permeable bag that expands inside the cavity. The bag limits the amount of insulation necessary to insulate the joist cavities at the floor perimeter.



Floor cavities: Floor cavities are difficult to fill in platform-framed homes. Blow a plug of insulation into the floor cavity to insulate this uninsulated area.

Injecting Liquid Foam

Select insulation that has a flame spread and smoke development index of 75/450 or less.

Injecting liquid foam is more expensive than blowing fibrous insulation, but liquid foam provides better performance when existing walls are partially filled by batts. The batts are often 1-to-2 inches thick and fit flush to the interior or exterior wall surface. Try injecting the foam from outdoors to fill the cavity and compress the batt slightly. From indoors, the foam may just stretch the batt facing and fail to create a fully insulated wall cavity.

Open-cell polyurethane foam, formulated to expand less than the sprayed variety, is the leading wall-retrofit foam. Technicians install the foam through holes (<1 inch) spaced about two feet apart using a simple nozzle that barely enters the cavity. Technicians use drinking straws or other indicators to judge the

level that the foam has filled during installation. Technicians don't normally use fill tubes to inject open-cell foam because the tube would be too difficult to clean.

See "Special Safety Precautions for Spray Foam" on page 116.

Video: Densepack retrofit insulation tools and procedures— Hoses, area prep, dense-packing from indoors and outdoors, area cleanup.

5.3.5 Open-Cavity Wall Insulation

SWS Details: 4.0201.1 SPF Insulation; 4.0201.2 Batt Insulation; 4.0201.3 Dense Pack Insulation

Fiberglass batts are the most common open-cavity wall insulation, but rock wool may have a quality advantage over fiberglass. Batts achieve their rated R-value only when installed carefully.

A variety of sprayed insulation products may out-perform batts with expert installation. However, these products are more expensive and have their own installation challenges.

This section describes ways of installing wall insulation.

1. Installing batts in an open wall cavity.
2. Spraying wet-spray fiberglass or cellulose into an open wall cavity.
3. Spray open-cell or closed-cell foam into an open wall cavity.
4. Blowing fibrous insulation behind netting.

SPF insulates, seals, and reinforces brick wall: In this installation, open-cavity spray foam performs three separate functions.

R-15 fiberglass batts: install unfaced batts as shown on the right. Cut the batts accurately and install them carefully.

Open-Cavity Batts

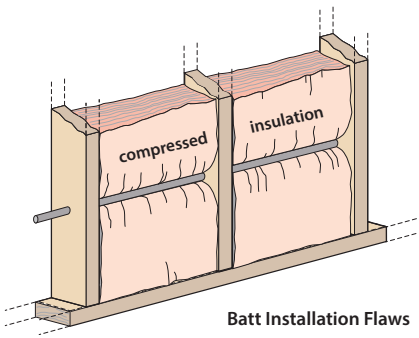
- ✓ Use unfaced friction-fit batt insulation where possible. Fluff the batts during installation to fill the depth of the wall cavity.
- ✓ Choose medium- or high-density fiberglass batts: R-13 or R-15 rather than R-11, and R-21 rather than R-19. Or, consider rock-wool batts.
- ✓ Seal all significant cracks and gaps in the wall structure before you install the insulation.
- ✓ Insulate behind and around obstacles with scrap pieces of batt before installing batts.
- ✓ Staple faced insulation to outside face of studs on the warm side of the cavity. Don't staple the facing to the side of the studs because this method leaves an air space that allows convection currents.
- ✓ Cut batt insulation to the exact length of the cavity. A too-short batt creates air spaces above and beneath the batt,

allowing convection. A too-long batt bunches and folds, creating air pockets.

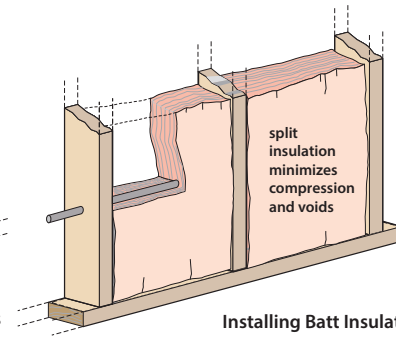
✓ Split batt around wiring, rather than letting the wiring compress the batt to one side of the cavity.

✓ Fiberglass insulation, exposed to the interior living space, must be covered with a thermal barrier or at least half-inch drywall or other material with a flame-spread rating of 25 or less.

✓ Fiberglass batts exposed to unoccupied spaces like attics must be covered with an air barrier such as house wrap or foam sheeting to prevent R-value degradation by convection and human exposure to fibers.



Fiberglass batts, compressed by a cable: This reduces the wall's R-value by creating a void between the insulation and interior wallboard.



Batt, split around a cable: The batt attains its rated R-value.

Sprayed Open-Cavity Wall Insulation

Both fibrous and foam insulation can be sprayed into open wall cavities. Varieties include the following.

- Fiberglass or cellulose mixed with water and glue at a special nozzle sprayed into the open wall cavity with the excess shaved off (fibrous damp-spray insulation)

- Open-cell or closed-cell polyurethane foam sprayed into an open wall cavity. Installers either spray the foam short of filling the whole cavity or shave off the excess foam after it cures.
- Select insulation that has a flame-spread /smoke-developed index of 75/450 or less.

Sprayed closed-cell foam: Installers spray closed-cell foam short of filling the cavity or else they shave the excess off.

Spray fibrous insulation: Installers blow wet-spray fibrous insulation into cavities and shave off the excess.

Blowing Open Wall Cavities behind Netting or Fabric

Blowing dry fibrous insulation behind netting or fabric is a common way of insulating open walls before drywall application, especially with cellulose. However, you must install the insulation to a sufficient density to resist settling.

- ✓ Select insulation that has a flame spread and smoke development index of 75/450 or less.
- ✓ Select a restrainer netting or fabric that supports the above densities without bulging excessively.

- ✓ Fasten the netting or fabric with power-driven staples, 1.5 inches apart.
- ✓ Verify density of at least 3.5 pcf for cellulose or 2.2 pcf for fiberglass.
- ✓ Roll bulging insulation with a roller to facilitate drywall installation.

5.3.6 Insulated Wall Sheathing

SWS Detail: 4.0202.2 Exterior Rigid Insulation

Insulated sheathing is an excellent retrofit, when you replace the siding and windows. Insulated wall sheathing covers an interior or exterior wall surface with insulation, reducing thermal bridging through structural framing.

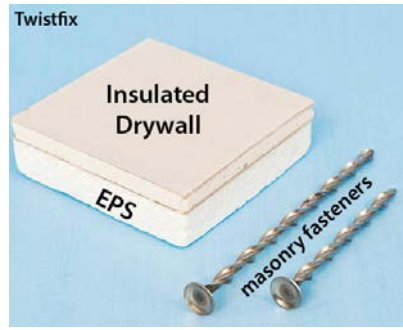
Always fill the wall cavity with insulation before installing insulated sheathing. Insulating wall sheathing is usually foam board, such as polystyrene or polyisocyanurate. Comply with these specifications.

1. Seal all holes, gaps, and penetrations in existing sheathing.
2. Some multifamily siding-replacement jobs require a "thermal barrier" like drywall as exterior sheathing for fire containment.
3. Verify that the existing exterior wall has a functional water-resistive barrier (WRB). House wrap, perforated tar paper, or the foam insulation itself may function as the WRB. However, consult with your building department to verify.

4. Fasteners should penetrate wood structure at least 1.5 inches.
5. Seal all insulation seams, joints and connections in each foamboard layer with compatible sealant — caulk, tape, or mastic, for example.

See also "Foundation Wall Insulation" on page 230.

Rigid-foam fasteners for masonry: Installers use power drivers to fasten rigid foam to masonry materials.



Insulated drywall: This specialty product works well for masonry and plaster interior walls.

Fasteners for Insulated Sheathing

Fastening the insulating sheathing requires one of the following to secure the insulation to the wood sheathing or masonry under it.

- A batten board
- An embedded strip
- A broad staple
- A long wood or masonry screw with a large washer
- A special adhesive (masonry)

Use appropriate fasteners for bonding foam to wood or masonry materials. Wood battens or embedded strips allow attachment of a variety of siding materials. The embedded strips work best with steel, aluminum, or vinyl sidings, which are lightweight

and which drain rain water through weep holes in every piece of siding.

If you plan to use a heavy siding, such as fiber cement or traditional stucco, consult a structural engineer to verify that the fasteners can adequately support the heavy siding.

Foam sheathing with battens: One-by-four battens are applied to 4 inches of foam board on the exterior to provide a fastening strip for siding and trim.

Foam with embedded strips: Strips of plywood or OSB are spaced on 16 or 24 inch centers at the factory. Wide corner pieces can be added on the job with foam cutting and grooving tools.

5.3.7 Wall Insulation in a Retrofitted Frame Wall

Retrofitters, seeking superior energy performance, sometimes build a wood-frame wall attached to the interior or exterior of the existing wall. Common insulation choices include all the wall-insulation choices discussed previously.

Select insulation that has a flame spread and smoke development index of 75/450 or less.

Workers must install vapor retarders, and air barriers into the new wall assembly as appropriate for the climate and existing wall characteristics. The exterior side of a retrofitted insulated

frame should have sheathing and a water resistive barrier like house wrap.

Frame wall for insulation: Technicians fastened a frame wall with brackets that place the wall away from the existing exterior wall by a half inch so that the sprayed foam can flow behind the studs and plates to reduce thermal bridging.

Open-cell polyurethane foam: The foam was sprayed into the cavities and the excess shaved off. New sheathing, house wrap, siding, and windows follow later.

5.3.8 Insulating Unreinforced Brick Walls

Unreinforced means that the builders used no steel or other metal reinforcement. There are three types of unreinforced brick walls.

1. Traditional brick walls with header bricks that hold two layers of stretcher bricks together. Larger buildings may have three or more brick layers instead of two.
2. Various types of cavity brick walls with usually one layer of brick on either side of a cavity.
3. Wood-frame brick veneer walls with a single layer of brick veneer that attaches to a typical wood frame wall with a cavity between the brick and the wood-frame wall up to 2 inches.

All three of these brick assemblies may have structural problems depending on the condition of the bricks and mortar joints.

Mortar can turn to dust over many decades; cavity brick walls can be frighteningly fragile; and small movements can topple 100-year-old brick veneer. **Consult a structural engineer before making any modification to an unreinforced brick building.**

See also "Basement Wall Insulation" on page 233.

Cavity brick wall: Two separate single brick walls are held together by wood lath embedded in the mortar joint.

Injectable foam: Installers inject low-density foam into a cavity behind a single brick wall.