WSEO Home Conserv

WASHINGTON STATE ENERGY OFFICE
Washington Energy Extension Service

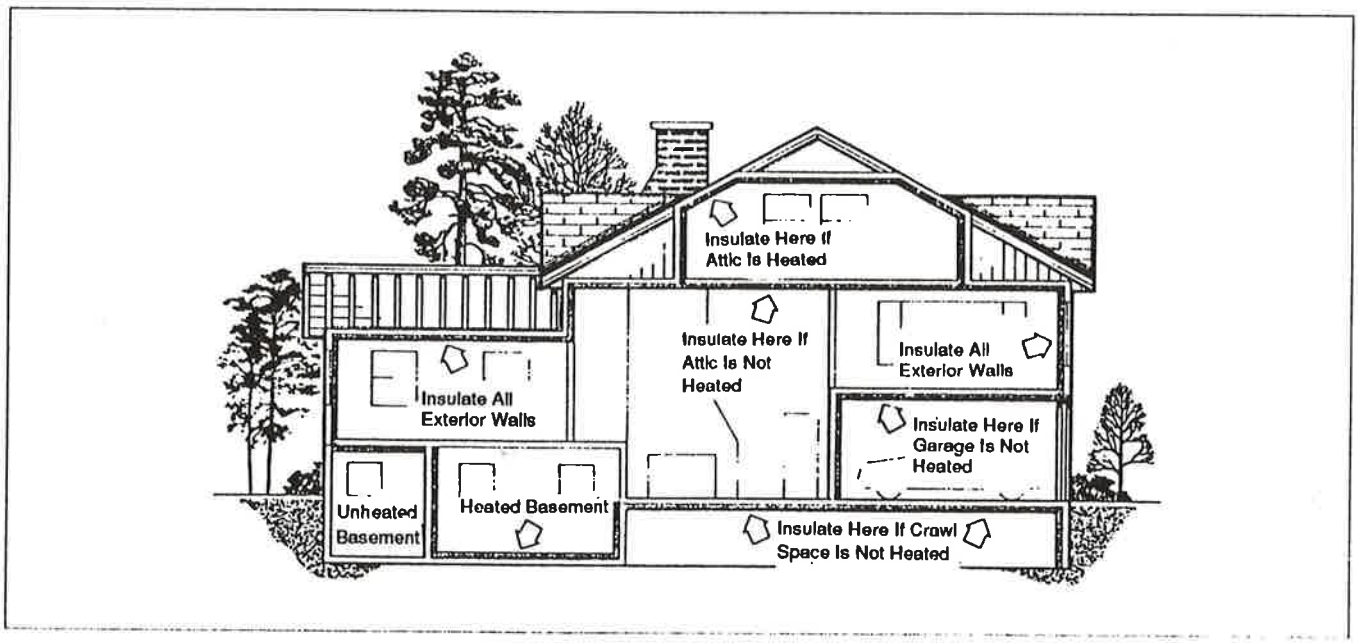
Wise Use of Resources Through Education

Home Insulation

As the cost of energy rises, homes can economically be insulated to higher levels. Insulating electrically heated homes also saves the region money by reducing the need for new generating facilities. For this reason, many utilities currently offer programs to help pay the costs of home insulation. Call the local utility for information on weatherization assistance. Generally speaking, you should consider adding insulation when: There is little or no existing insulation; attic, floor, or wall cavities are exposed during remodeling; utility programs are available to help with financing; low-cost weatherization measures have already been taken; or heating bills are high.

Adding insulation does more than just save money on winter heating bills. It makes the home quieter, less drafty, and more comfortable. It also reduces the need for air conditioning. This pamphlet gives information and specific techniques to help a homeowner install insulation. If a contractor is hired for the work, the information should prove valuable in making sure the job is done correctly.

Figure 1. Where to Insulate



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Conservation Priorities

Any conservation effort should begin with measures that are easy, inexpensive, and result in substantial energy savings. This includes the following steps where appropriate:

- Lower the temperature in rarely used living areas.
- Turn thermostats back at night and during the day if possible.
- Add low-cost, owner installed storm windows over single pane windows.
- Have a furnace tune up.
- Seal and insulate furnace ducts in unheated space.
- Reduce air leakage in the home.

Next come measures which cost more money, but have the potential to achieve substantial reductions in energy use. This includes adding insulation and improvement of older, inefficient heating systems. The subject of heating systems is covered in the WEES pamphlet, *Central Forced Air Heating Systems* (FS-1202).

As a general rule, insulate attic, floor, or wall cavities that separate heated from unheated space if they are accessible (see Figure 1). "Accessible" refers to insulation that can be installed without extensive removal of existing building materials, digging, drilling holes or other major expense. In addition, the following suggestions make good economic sense for most homes:

- In the attic, if there is less than R-19 (about 6 inches of insulation), add insulation to R-38.
- In heated basements, insulate exposed rim joists (the space between floor joists immediately above basement walls) to R-19.
- Insulate unfinished concrete walls in heated basements to R-19.
- Blow insulation into uninsulated frame walls only after considering other suggestions listed in this section.

It is possible to perform a more precise analysis of the cost effectiveness of insulation investments. Your insulation contractor or local utility may be able to assist in performing this analysis.

Table 1. Commonly Used Insulations

Insulation Type	R-Value Per Inch	Made From	Comments
Cellulose	3.5 - 3.7	ground wood or paper	• Often blown in attics and walls. • Additives provide resistance to fire and mold/fungus growth.
Fiberglass batt	3.0 - 3.8	strands of molten glass	• Fits best in standard joist widths. • Fire and mold resistant. • Eye, skin, and throat irritant at time of installation.
Fiberglass loose-fill	2.2 - 3.0	strands of molten glass	• Lightest loosefill insulation. • Fire and mold resistant. • Can irritate skin, eyes, and throat.
Rockwool or mineral wool	2.7 - 3.0	molten rock or slag	• High fire resistance. • Available in blankets or batts • Can irritate skin, eyes, and throat.
Rigid board expanded polystyrene	4.0	petrochemical	• Often white "beadboard" material. • Can absorb water, best used inside. • Burns with toxic smoke; needs fire barrier if used inside the home.
Rigid board extruded polystyrene	4.6 - 5.0	petrochemical	• Water resistant; good for exterior use and below grade. • Needs firm barrier if used inside. • Serves as a vapor barrier.
Rigid board polyurethane or isocyanurate	6.0 - 7.0	petrochemical	• Often used as exterior sheathing, but not below grade; absorbs water • Generally foil faced on both sides. • Foil serves as a vapor barrier.
Vermiculite	2.2	silicate minerals	• Non-combustible, non-irritating. • Rarely used now in attics; heavy. • Good for chimney flue insulation.
Wood Shavings	2.5	—	• Hard to treat against fire, vermin, and fungal growth.

Materials And R-Values

Insulation is rated by its ability to resist heat flow, indicated by the R-value. This number can be found on insulation packaging; the higher R-values mean more effective insulation. When materials are combined, individual R-values are added to get a total. For example, an R-11 insulation batt together with an R-19 batt totals R-30.

The thickness of insulation required to achieve a given R-value varies with the material used. Insulating materials have tiny pockets that trap air inside, and it is the dead air that does the insulating. An average value for air based insulation is around R-3 per inch. A typical R-19 insulation batt will be about 6 inches thick, an R-11 batt about 3-1/2 inches thick.

Some foam insulations trap gasses such as Freon (a trade name) in their cells, and claim values as high as R-8 per inch. These are particularly useful where space is limited. Studies indicate that over time the gas can escape and be replaced by air, resulting in an aged value of R-5 or R-6 per inch. This aged R- value is a more reliable indicator of long term performance. Table 1 lists common types of insulation and some of their characteristics.

Moisture, Air/Vapor Barriers And Ventilation

Adding insulation can aggravate moisture problems. When moist air from inside the home leaks into a ceiling or wall, it may condense and wet surrounding building materials causing stains, mold, and rot. The cure is to keep moist air out of the building envelope by sealing air leaks inside the home to form an air barrier. The air barrier also reduces heating bills by keeping cold air out. Air barriers are further discussed in the *Reducing Home Air Leakage* pamphlet listed at the end of this publication.

Even with the home sealed against air leakage, water vapor can still diffuse directly through building components. So in addition to the air barrier, a good vapor barrier is required for complete moisture protection. In our heating climate, the vapor barrier always goes between the insulation and the heated space. Listed below are options for vapor barriers:

- Insulation with kraft or foil facing.
- Sheets of polyethylene or aluminum foil.
- Three coats of semi-gloss enamel on smooth interior surfaces.
- Three coats of urethane varnish on interior wood paneling.
- Vapor barrier rated paints over sheetrock.
- Washable plastic or vinyl wallpaper.

Moisture problems can be greatly reduced by producing less moisture in the home, and using kitchen, bath, and laundry room exhaust fans. Attics and crawlspaces must also be vented to remove moisture that gets past the air/vapor barriers, and to help keep the home cooler in summer. The amount of ventilation needed depends on the size and condition of the space being vented. Attics and crawlspaces require at least 1 square foot of evenly distributed, free (unobstructed) vent area for each 300 square feet of floor or ceiling space; they may require twice that amount under high moisture conditions. Call your local building department for further recommendations on vent area and proper location of vents.

Safety

Fire safety is an important question when insulation is added to a building. Some insulation materials will not burn themselves, but may contain resins or have paper facing that will. Insulations made from wood or paper products must be treated with fire retardant to pass government specifications. Do not install cellulose insulation unless the government specification number GSA-HH-I-515D is stamped on the bag. Most foam insulation boards give off toxic gas if ignited, and are covered with 1/2 or 5/8 inch sheetrock (or equivalent) to satisfy local code.

Insulation should not come into contact with heat producing light fixtures and electrical components, or chimneys. Open topped, nonflammable baffles maintain the required side air space (usually 3 inches). Take care that blown insulation does not drift inside the baffles (see Figure 2). Special care must be taken with the older knob and tube type of electric wiring, particularly if there are problems with dimming lights and blown fuses. When in doubt, check with the local building department for advice.

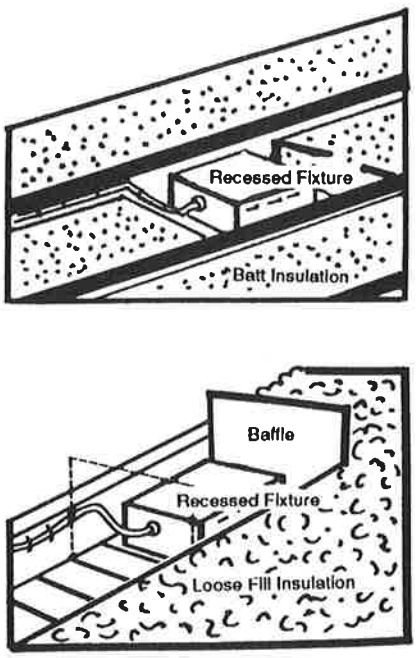


Figure 2. Electrical Fixture Baffle

Insulating Attics And Ceilings

Open Attic Space:

Insulation batts or blankets are easy to install, but may not fit well if joists are unevenly spaced. Running a second layer of insulation crosswise to the first helps seal cracks and reduces heat loss from joists. If a vapor barrier already exists next to the ceiling, slash foil or kraft facing on the second layer with a knife, or use unfaced batts. This will prevent moisture problems from a double vapor barrier. If no vapor barrier is present next to the ceiling, one may be added beneath the second layer of insulation (using plastic, kraft paper, or foil) as long as the insulation on top has at least twice the R-value of that below.

Loosefill insulations fill irregular horizontal spaces and usually result in more complete coverage than batts. They can be blown from a machine or poured from bags by hand. Machines for blowing insulation are available at rental stores or from the company that sells insulation. Complete all baffling and preparatory work before blowing insulation. Start with the furthest and most difficult area to reach from the access hatch, and finish with the access hatch itself. Three joist spaces are usually blown at a time, with the direction of flow parallel to the run of the joist. As attic space narrows toward the eaves, insulation must be tapered to allow at least 1 inch of space for air movement from eave vents. Rigid insulation can be used here to maintain full R value with the decreased thickness (see Figure 3).

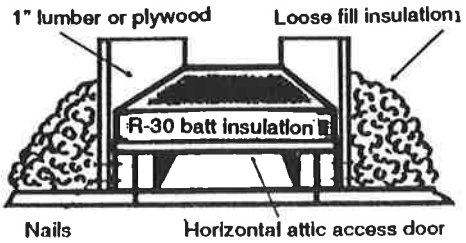
The blowing machine must be properly set to avoid mixing too much air and overfluffing the insulation, as this can result in excessive settling later on. When work is completed, all baffling should be inspected and cleared of insulation overblow as necessary.

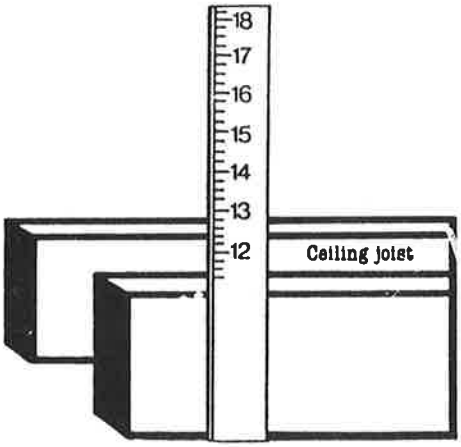
Every bag of loosefill insulation carries a label that tells you how many bags to use per area of square feet to achieve the desired R-value. Whether owner or contractor installed, be sure to check the label and count the bags used to make sure coverage is adequate. Cellulose is heavier than fiberglass insulation. If it is blown on top, be sure to add extra cellulose to compensate for settling of the lighter layer beneath. Be careful to maintain the required clearances around heat producing objects.

One-and-a-half Story Attic Space

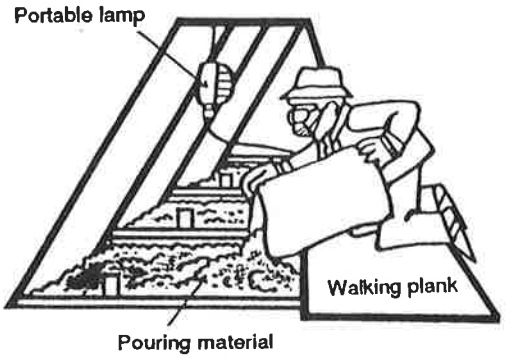
This type of attic presents a combination of flat and sloped ceilings, as well as short kneewalls. The

Figure 3. Tips for Insulating Attics





Attach measuring sticks to ceiling joists to measure depth of loose fill insulation



three flat sections (one on top, two at the sides of the kneewalls) can be insulated like an open attic space (see Figure 4). The kneewalls should be insulated to R-19, with an air/vapor barrier toward the heated space. It may be necessary to cut access hatches into these areas.

A number of options exist for insulating the short section of a sloped ceiling. Board, batt, or loosefill insulation can be installed between the rafters into the sloped area, leaving at least 1 inch of airspace between the insulation and roof sheathing. In this limited space, foam board gives the highest R value. Vents should be installed in all three attic spaces (top and sides).

An alternative is to fur out the sloped sections on the inside, adding insulation and a new air/vapor barrier (see Figure 5). Two layers of foam with strapping at right angles can be used to attain higher levels of insulation. This method could be used on the kneewalls and the overhead ceiling section as well. It can also be used on open beam and cathedral ceilings. Sheetrock must form the new interior wall covering for fire protection. With this method, if there is an existing vapor barrier, it should be punctured to prevent moisture problems associated with a double vapor barrier. A third alternative is to insulate the entire roof from the exterior as described in Figure 6.

Sloped Ceilings

Sloped and cathedral type ceilings can be insulated from the interior as just described, or they can be insulated from the exterior when the home is re-roofed. A variety of exterior methods are possible using either rigid or batt insulation. One possibility is shown in Figure 6. Insulating outside allows the interior to remain unchanged, but is an expensive option unless the roof needs replacing anyway. An existing air/vapor barrier can be retained, or a new one added beneath the exterior insulation as long as there is at least twice as much R value above the barrier as below. Any ventilation in the attic below the old roof must be sealed off, and provisions made for ventilation above the new insulation layer. Continuous soffit and ridge vents work well in combination.

Insulating Underfloors, Basements, And Crawlspaces

After attic insulation, the next most cost-effective measure is to insulate the floor, basement, or crawlspace (see Figure 7). Insulation is placed underfloor if the space below is unheated. If the basement is heated or may be heated in the future, insulate the basement walls. Insulating crawlspace perimeter walls does not save as much energy as insulation underfloor, but may be preferable in areas with severe winters as the crawlspace will stay warm and prevent water pipes from freezing.

Figure 4. Attic Types

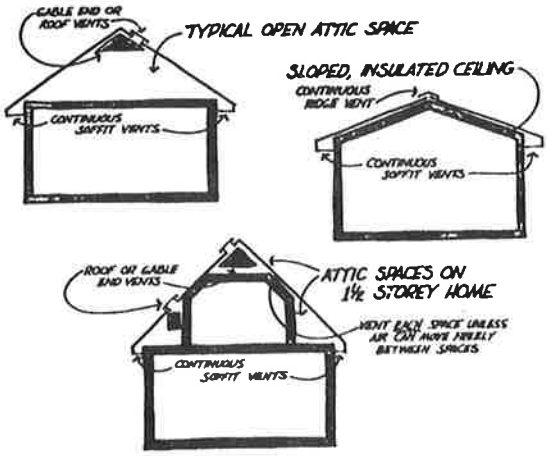


Figure 5. Insulating Interior Surfaces

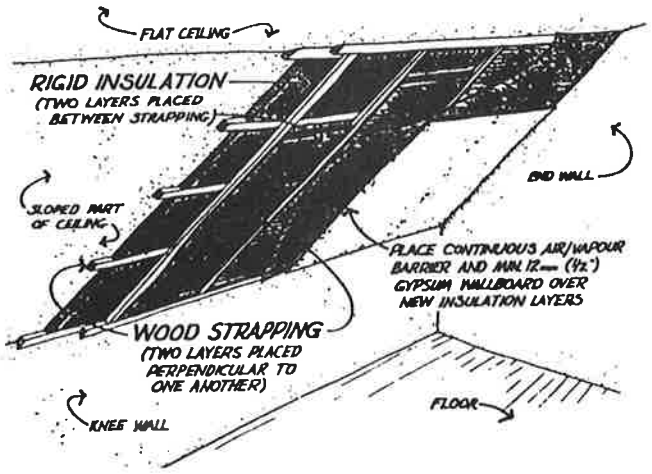


Figure 6. Exterior Roof Insulation

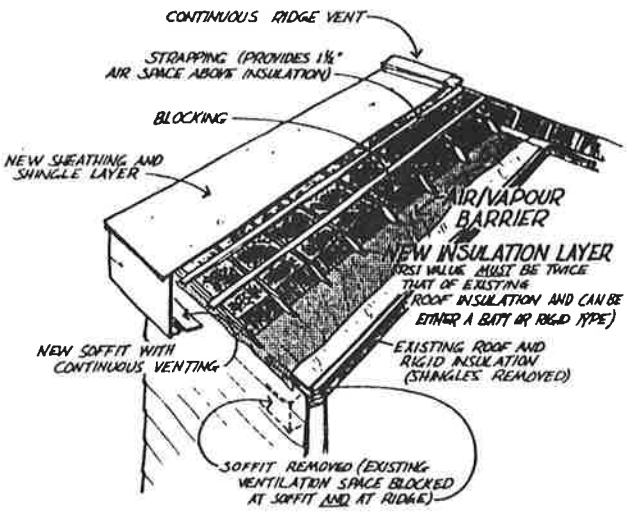
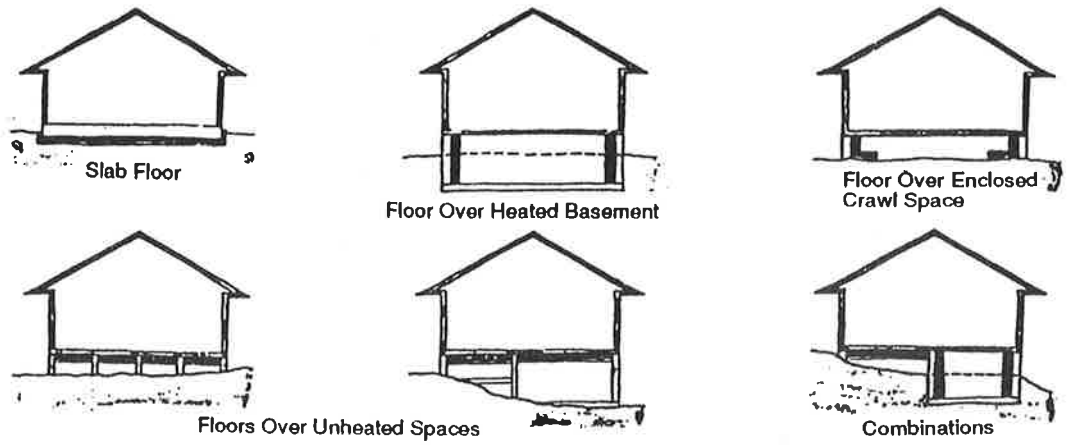


Figure 7. Insulating Underfloor, Basements, and Crawlspaces



Potential moisture problems should be attended to before insulating. This includes fixing concrete wall and foundation cracks, and elimination of standing water.

Underfloors

Insulate with batts of the appropriate width. The paper or foil face is placed next to the floor which means the paper flange cannot be used to secure the insulation. Support the insulation from below at frequent (approximately 1 foot) intervals with wood lathe, plastic twine, galvanized chicken wire, or other corrosion resistant materials. Nails and staple fasteners must also be galvanized or zinc coated to prevent rusting. Friction fit wire hangers can come loose and are not recommended.

Exposed earth in a crawlspace should be covered with a 6 mil black plastic sheet barrier, lapped 12 inches at the joints. Ventilate the crawlspace year round to local building department recommendations. Insulate exposed water pipes to at least R-3 and heating ducts to R-11. In areas with sustained freezing weather, pipe heaters may be installed in direct contact with the pipe beneath the insulation. Basements with dirt floors should be treated as a crawlspace with ground cover and provision for adequate ventilation.

Basement Walls

After treating any moisture problems, concrete basement walls can be framed and insulated to R-19 with batts or rigid foam board on the interior. Include a vapor barrier next to the heated space. Foam boards can be glued directly to concrete, but then there is no easy way to attach the sheetrock or required fire cover. Be sure to insulate the rim joist as well (the area between floor joists, above the concrete wall). Basement walls can also be insulated on the exterior (see Figure 8).

The best material for use below grade (buried) is extruded polystyrene rigid insulation. It is waterproof and will not compress with the weight of backfill. It must be covered for protection from sunlight and weathering above grade. In new construction, the board can be extended down to the footing or the frost line. In a retrofit situation, it is easier to install part of the insulation vertically to the frost line (or 2 feet minimum), with the rest sloping horizontally away from the wall for 2 feet. Insulation board is glued to the foundation with adhesive run in continuous horizontal beads to block insect infestation. Soil beneath the horizontal layer must be well compacted. Do not excavate below the level of foundation footings.

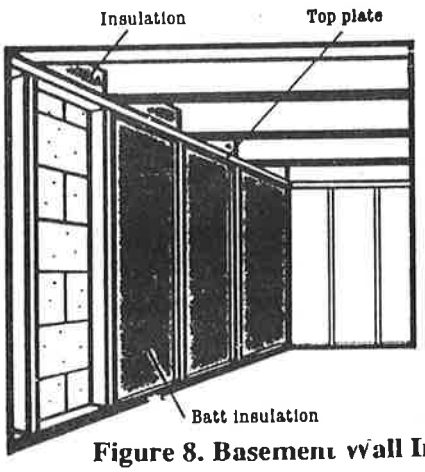
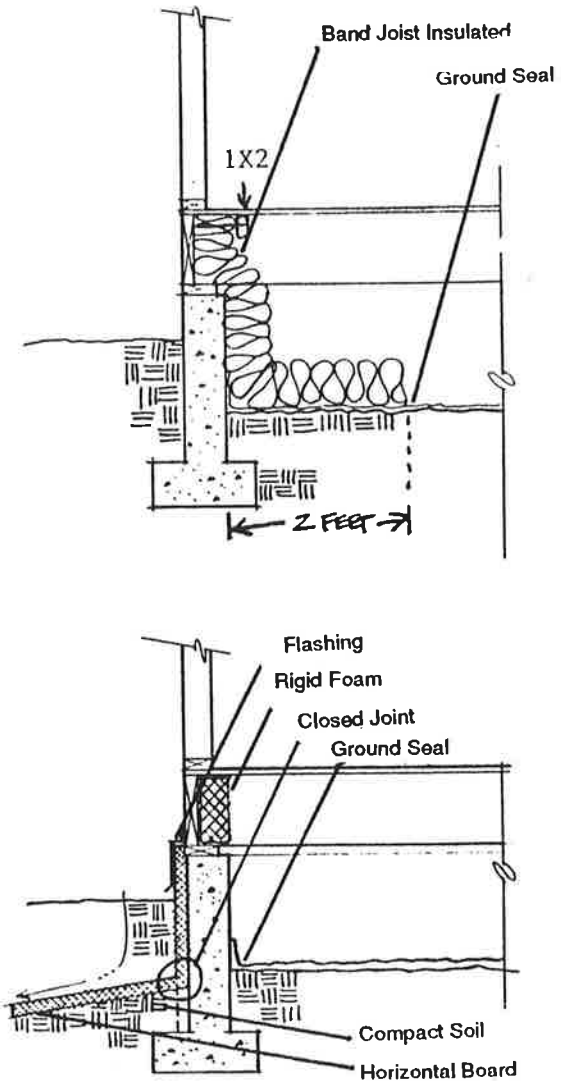


Figure 8. Basement Wall Insulation

Figure 9. Crawlspace Perimeter Insulation



Crawlspace Perimeters

Perimeter insulation is an alternative to underfloor insulation where pipe freezing is a problem in winter or where the crawlspace is used for hot air distribution (see Figure 9). It is not recommended for homes with high radon gas levels, as radon is trapped in the crawlspace when vents are closed in winter. Insulation can be installed on the interior or exterior. Exterior insulation is described in the section on "Basement Walls."

On the interior, R-19 batt insulation is fastened to the subflooring, extended downward over the rim joist to the crawlspace floor, and inward from the base of the foundation wall a distance of 3 feet on top of the ground cover. Seams between adjacent batts should be continuously taped or stapled. Operable crawlspace vents are used to close the space off in winter and hold in heat, and to open vents in summer to vent moisture.

Basement Floors

Insulating concrete floors in heated basements may be hard to justify economically but it can increase the comfort level considerably (see Figure 10). A carpet with a thick pad helps, but it is more effective to build an insulated subfloor or sleeper floor. Before insulating, check for moisture by taping square pieces of polyethylene plastic at several locations on the floor. If a damp spot occurs within 24 hours, the floor is too moist. If dry, begin by placing a polyethylene moisture barrier down, then frame and insulate a subfloor with rigid foam or batts. Shim as necessary for a level surface. Add a second poly layer for an air/vapor barrier, then add plywood sheeting and the finished floor covering.

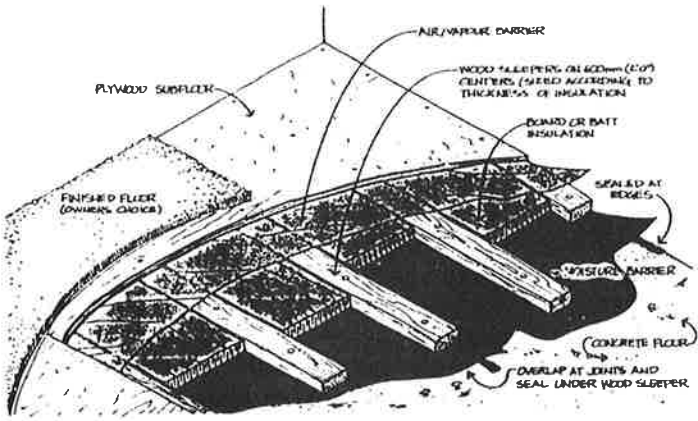


Figure 10. Basement Floor Insulation

Insulating Frame Walls

The expense of equipment and labor required to blow insulation into existing walls makes this a low priority for most homes. However, remodeling or residing the home presents an opportunity to add insulation less expensively.

If residing the exterior, rigid foam board can be applied beneath the new siding. Install 3/8 inch furring strips (plaster lathe) over the rigid insulation and nail siding to these strips. The furring strips allow air movement to prevent moisture induced paint and siding failure. Do not tape joints between exterior insulation boards, but rather install a good air/vapor barrier on the interior wall surface.

Foam board can also be applied over interior walls when remodeling. If more than 1-1/2 inches of foam is installed, add furring strips over the foam to provide a stable nailing base for the wall covering. All foam insulations give off a toxic gas when they burn and must be covered with a suitable fire stop, usually 1/2 or

5/8 inch sheetrock. The interior wall should be treated as described earlier to form the air/vapor barrier.

When remodeling involves opening a wall cavity, it is quite simple to put in the properly sized fiberglass blanket. Even when kraft or foil faced insulation is used, it is smart to install a polyethylene vapor barrier over the insulation to help seal air leaks.

Without remodeling, the only way to add wall insulation is to blow it in. Cellulose, fiberglass, rockwool, and urethane foam are in current use, but due to problems with formaldehyde vapor, urea-formaldehyde foams are now rarely employed. Do not blow insulation into partially insulated walls or walls less than 3 1/2 inches thick. Walls containing electric heaters or old electrical wiring need baffling or special care.

The need for professional installation is one reason the cost of this procedure is high. It can be difficult to completely fill walls with insulation in some cases, and careful finishing is required to mask the drill holes. Taking time to find a reputable installer is the best way to ensure a satisfactory job.

In this pamphlet we have discussed prioritizing conservation efforts, materials used for insulation, moisture and air barrier considerations, and actual techniques used to insulate homes. Further information on home insulation is available from the sources listed below, your local utility, or from the Washington Energy Extension Service.

Written by Jerry Graser, Chuck Eberdt, and Ed Valbert.

Illustrations courtesy of the Bonneville Power Administration, Alberta Department of Energy, and Lane Publishing.

Suggested Reading

Do-It-Yourself Home Weatherization Guide. Published by the Bonneville Power Administration. Available at electrical utilities or from the BPA.

Do-It-Yourself Insulated Window Shutters. Oregon State University Extension Service, Agricultural Communications, Publications Orders, Oregon State University, Corvallis, OR.

Energy Savings Decorating. Judy Lindahl, Portland, OR. How to make Roman shades, shutters, cornices, and valances and improve existing window treatments.

How to Make Your Polar Guard Roman Shade. Magnet Store, Castle Rock, CO.

Insulating Window Shade. Ray Wolf, Rodale Press, Emmaus, PA. Step-by-step building and installation instructions and blueprints.

Insulation and Weather-stripping. Sunset Books. Lane Publishing, 1978. Judy Lindahl. A well illustrated and useful reference for homeowners.

Movable Window Insulation. Stephaus and Wezelman, Sunrise Co-op, Davis, CA. Describes nine interior movable insulation options.

Shade Book, The. Judy Lindahl, Portland, OR. How to make your own roller, Roman, balloon, and Austrian shades.

Twelve Insulated Shades. Phyllis L. Fizgerald, The Urban Alternative Homestead, Louisville, KY. How to make and install 12 energy-efficient treatments.

WEES Publications

Reducing Home Air Leakage (FS-1101)
Storm Windows (WAOENG-89-11)
Performing Heat Loss Calculations (FS-1201)
Insulated Window Covers (FS-1104)
Reducing Moisture Problems (FS-1802)
Central Forced Air Heating Systems (FS-1202)

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