CEILINGS AND ATTICS

Install Insulation and Provide Ventilation

Buildings for the 21st Century

Buildings that are more energy-efficient, comfortable, and affordable…that's the goal of DOE's Office of Building Technology, State and Community Programs (BTS). To accelerate the development and wide application of energy efficiency measures, BTS:

- Conducts R&D on technologies and concepts for energy efficiency, working closely with the building industry and with manufacturers of materials, equipment, and appliances
- Promotes energy/money saving opportunities to both builders and buyers of homes and commercial buildings
- Works with State and local regulatory groups to improve building codes, appliance standards, and guidelines for efficient energy use
- Provides support and grants to States and communities for deployment of energy-efficient technologies and practices

BENEFITS OF CEILING INSULATION

Insulating ceilings is one of the most cost-effective energy efficiency measures. In addition to reducing heat loss in the winter and heat gains in the summer, ceiling insulation improves comfort by bringing ceiling temperatures closer to room temperatures and providing an even temperature distribution throughout the house.

When planning and managing ceiling insulation projects, make sure

- Ceiling is properly sealed
- Correct insulation levels are selected
- Insulation is properly installed
- Insulation coverage is continuous and complete
- Attic ventilation is maintained

Attic floors over flat ceilings are often the easiest part of an exterior building envelope to insulate. They are usually accessible and have ample room for insulation. However, many homes use cathedral ceilings or have attic knee walls that present unique insulation requirements.

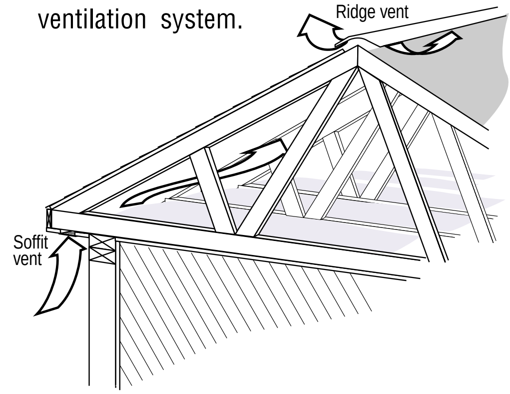
ATTIC VENTILATION

Most building codes require roof vents to expel moisture that could cause insulation or other building materials to deteriorate during winter. In summer, ventilation may reduce roof temperatures, thus lengthening a roof's life.

However, researchers are investigating whether attic ventilation is beneficial for all climates. For years, researchers have believed the cooling benefits of ventilating a well-insulated attic are negligible. Some experts also question whether ventilation effectively removes moisture. Until the research results are available and accepted, builders should follow local code requirements, which usually dictate attic ventilation.

ATTIC VENTILATION

Continuous ridge and soffit vents form an effective attic ventilation system.



A combination of continuous ridge vent along the peak of the roof and continuous soffit vents at the eaves provides the most effective ventilation. A rule of thumb is to use 1 sq. ft. of net vent opening for every 150 sq. ft. of insulated ceiling or 1:300 if the insulation has a vapor barrier. Vent area should be divided equally between the ridge and soffits.

Cap vents and gable vents can supplement a roof design that has insufficient ridge vent area. Turbine vents can also be used, although they require annual maintenance. Electrically powered roof ventilators are not recommended because they consume more energy than they save. Powered vents can also remove conditioned air from a home through ceiling leaks and bypasses, pull pollutants from the crawlspace into a home, and cause exhaust gases from fireplaces and combustion appliances to enter a home.

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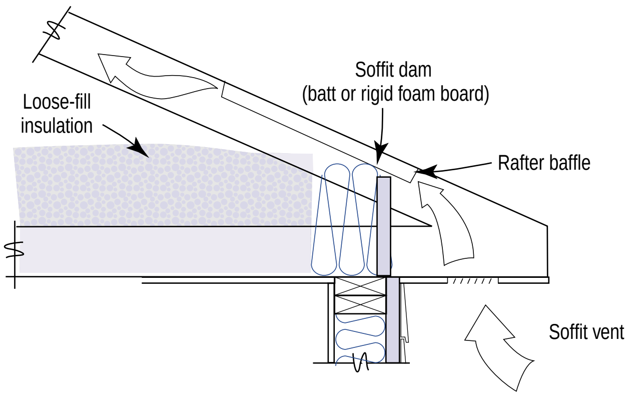
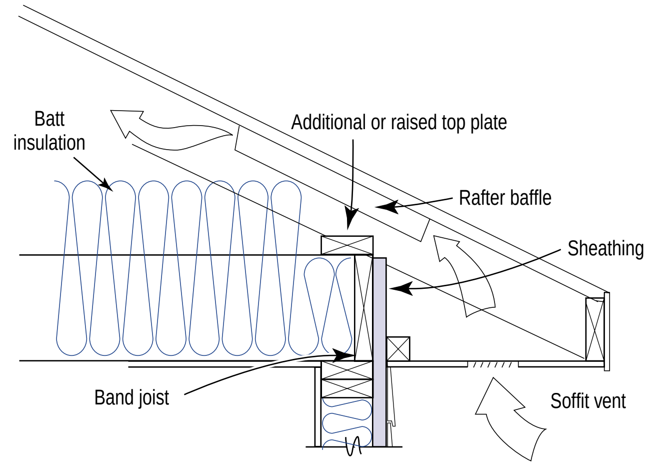
ATTIC EAVES



This oversized truss shows loose-fill insulation that is blocked or dammed at the eave with a soffit dam (a piece of fiberglass batt or rigid insulation). A rafter baffle creates a channel for air flow.



A raised top plate increases the height for insulation and ventilation at the eaves.

INCREASING THE ROOF HEIGHT AT THE EAVE

One problem area in many roof designs occurs at the eave, where there is often insufficient space for full insulation without blocking air flow from the soffit vents. Often the insulation is compressed to fit the space, diminishing its R-value.

For a truss roof, consider *raised heel* or *oversized (cantilevered) trusses* that form elevated overhangs in combination with rafter baffles and soffit dams. These should provide clearance for both ventilation and full-height insulation. Use of 2- to 2½-foot overhangs also provides more room for insulation at the wall junction and additional window shading.

In stick-built roofs, where rafters and ceiling joists are cut and installed on the construction site, laying an additional top plate across the top of the ceiling joists at the eave will raise the roof height, prevent compression of the attic insulation, and permit ventilation. When installing a raised top plate, place a band joist at the open joist cavities of the roof framing. The band joist helps prevent windwashing of the attic insulation—where air entering the soffit vents flows through the attic insulation—which can reduce attic insulation R-values on extremely cold days or add moisture to the insulation. The band joist also serves as a soffit dam for the insulation.

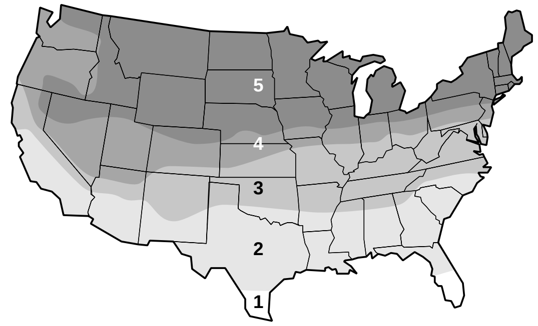
CEILING INSULATION R-VALUES

The 1995 Model Energy Code (MEC) and DOE Insulation Fact Sheet provide recommended R-values for geographical locations in the continental United States. The following table provides some general guidance.

HDD Zone		Ceiling R-value
1	(0-500)	R-19
2	(501-3,000)	R-30
3	(3,001-5,000)	R-38
4	(5,001-6,000)	R-38
5	(6,001-10,000)	R-49

HDD=Heating Degree Days

(Consult your local weather bureau for your city's actual annual heating degree days.)



ATTIC INSULATION TECHNIQUES

Loose-fill or batt insulation is typically installed in an attic. Although installation costs may vary, blowing loose-fill attic insulation—fiberglass, rock wool, or cellulose—is usually less expensive than installing batts and provides better coverage.

✓ **Steps for installing loose-fill and batt insulation**

1. Seal all attic-to-home air leaks, especially chases, dropped ceilings, wiring and plumbing penetrations, light fixtures, and bathroom fans. Most insulation does not stop air flow.
2. Install blocking (metal flashing) to maintain clearance requirements (usually 3 inches) for heat-producing equipment found in an attic, such as flues, chimneys, and exhaust fans.
3. Use only IC-rated recessed lights because they are airtight and can be covered with insulation.
4. Select insulation levels in accordance with the 1995 MEC or the DOE Insulation Fact Sheet. The Insulation Fact Sheet (DOE/CE-0180) can be ordered from the Energy Efficiency and Renewable Energy Clearinghouse or accessed from the Internet at www.ornl.gov/roofs+walls.
5. Locate the attic access in an unconditioned part of the house if possible. Otherwise, weatherstrip the attic access and insulate it by attaching insulation to the cover or by installing an insulated cover box.
6. If mechanical equipment or storage areas are located in the attic, elevate the attic decking to allow full-height insulation to be installed.

✓ **Additional steps for installing loose-fill insulation**

1. Prior to hanging ceiling drywall, install rafter baffles to preserve ventilation from soffit vents and use insulation dams at the soffit, porch, garage, and attic access to prevent the insulation from spilling.
2. Follow the manufacturer's specifications (number of bags per square feet) to obtain complete coverage of the blown insulation at consistent depths and to avoid fluffing the insulation.
3. As required by the 1995 MEC, make sure the installer:
   - Provides attic rulers to show proper blown depth (facing the attic entrance, one ruler for every 300 sq. ft.)
   - Provides an accurate attic "report card" showing that sufficient density was installed

✓ **Additional steps for installing batt insulation**

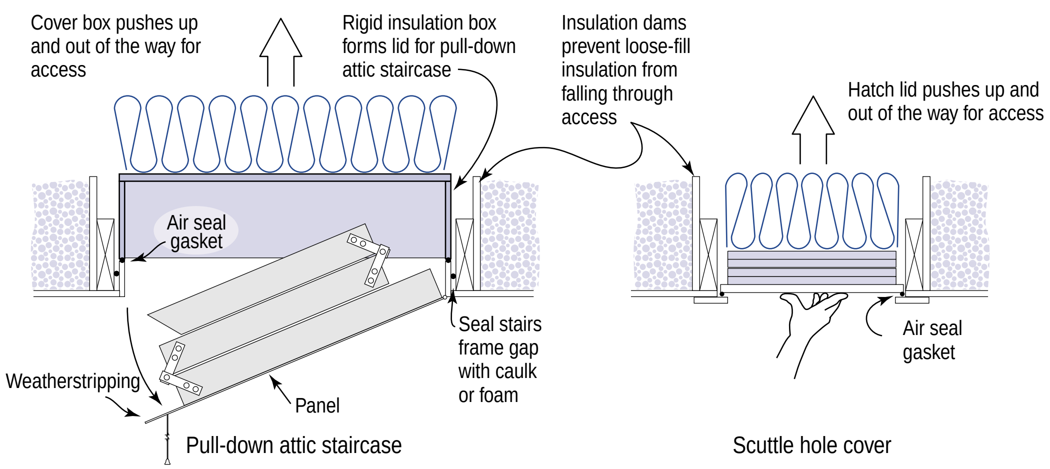
1. Cover the top of the ceiling joists or the bottom cord of the truss with insulation.
2. Obtain complete coverage of full-thickness, non-compressed insulation. Make certain batts completely fill the joist cavities. Shake batts to ensure proper loft. If joist spacing is uneven, patch gaps in the insulation with scrap pieces. Do not compress the insulation with wiring, plumbing or ductwork (cut slits in the insulation if necessary).

ENERGY-EFFICIENT CATHEDRAL CEILINGS

Cathedral ceilings must provide space between the roof deck and ceiling for adequate insulation and ventilation. For most areas of the U.S., the 1995 MEC recommends R-25 to R-38 insulation in a cathedral ceiling. This can be achieved through the use of truss joists, scissor truss framing, or sufficiently large rafters. For example, cathedral ceilings built with 2x12 rafters have space for standard 10-inch, R-30 batts and ventilation.

ATTIC ACCESS

When the attic access is located in the conditioned space of the house, build an insulated attic access cover to provide continuous ceiling insulation coverage and use blocking to prevent full-height, loose-fill insulation from falling through the access.



Pull-down attic staircase

Scuttle hole cover

CEILINGS AND ATTICS

For more information, contact:

Energy Efficiency and Renewable Energy Clearinghouse (EREC)
1-800-DOE-3732
www.eren.doe.gov

Or visit the BTS Web site at
www.eren.doe.gov/buildings

Or refer to the Builder's Guide
Energy Efficient Building Association, Inc.
651-268-7585
www.eeba.org

Written and prepared for the U.S. Department of Energy by:

Southface Energy Institute
404-872-3549
www.southface.org

Oak Ridge National Laboratory
Buildings Technology Center
423-574-5178
www.ornl.gov/ORNL/BTC

The Model Energy Code can be obtained from the International Code Council by calling 703-931-4533

MECcheck, a companion compliance software package, can be ordered from DOE by calling 1-800-270-CODE or downloaded directly from the Web at www.energycodes.org/resid/resid.htm.

Foil-faced batt insulation is often used in cathedral ceilings because it has a 0.5 perm rating and provides the permeability often required for use in ceilings without attic spaces. A *vent baffle* should be installed between the insulation and roof decking to ensure that the ventilation channel is maintained.

If roof framing provides insufficient space for required insulation, higher insulation values can be obtained by either attaching furring strips to the underside of the rafters (that permit additional insulation to be installed), using high-density batts (high-density R-30 batts are about the same thickness as R-25 batts and fit into 2x10 framing), or adding rigid foam insulation under the rafters. Rigid foam insulation offers a resistance to thermal bridging through wood rafters. Rigid foam insulation must be covered with a fire-rated material when used on the interior of a building. Half-inch drywall usually complies, but check with local building codes for confirmation.

KNEE WALLS

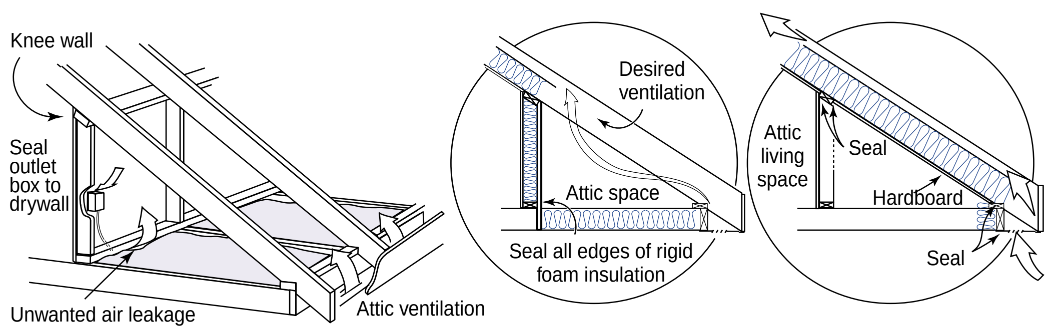
Knee walls are vertical walls with attic space directly behind them. They are often found in houses with finished attics and dormer windows, such as in story-and-a-half designs.

One approach to constructing an energy-efficient knee wall is to first air seal the knee wall using conventional techniques (i.e., seal the bottom plate, seal penetrations through the drywall, etc.). The open joist ends below the knee wall should be plugged with squares of cardboard, metal flashing, or rigid insulation; cellulose insulation blown at a high density; or batt insulation stuffed into plastic bags. The plugs should be sealed to the joists using caulk or spray foam.

The knee wall and attic floor in the attic space behind it should be insulated to recommended levels. The same techniques for achieving higher insulation levels in cathedral ceilings can be applied to knee walls. Twine is often used to hold the batt insulation in place. The technique of adding rigid foam insulation over the framing is particularly effective. Rigid insulation can be notched to fit over the floor joists. Sealing rigid insulation to floor joists effectively blocks open floor joists.

A better approach is to insulate and air seal the rafter space along the sloping ceiling of the knee wall attic space. The rafters should receive recommended insulation levels. They should be covered with a sealed air barrier, such as drywall or foil-faced hardboard. The barrier must be caulked to the top plate of the exterior wall below the attic space and to the top plate of the knee wall itself. All other cracks and holes must be sealed as well. One advantage of this technique is that any ductwork located in this space is now inside the conditioned space.

ATTIC KNEE WALL DESIGN



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