# CRAWLSPACE INSULATION

*Improve comfort and increase durability in the home*

## 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

## EFFECTIVE CRAWLSPACE INSULATION

A properly sealed, moisture-protected, and insulated crawlspace will increase comfort, save on energy costs, improve the durability of the home, and reduce entry of moisture, radon, and other potential irritants or pollutants into the home. Whichever design is followed, the keys to an effective crawlspace are:

**Moisture control** – using a water-managed foundation system to drain rainwater and groundwater away from foundations.

**Airtight construction** – sealing all air leaks between the conditioned space and the outside prior to insulation installation.

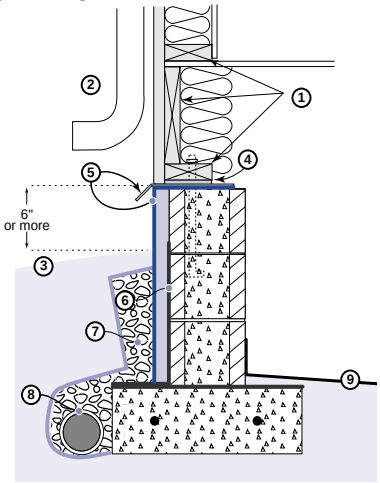
**Complete insulation coverage** – properly installing the correct insulation levels and making sure the insulation coverage is continuous and complete.

## WATER-MANAGED FOUNDATION SYSTEM

A crawlspace is susceptible to moisture and deterioration problems because of contact with the earth. The best approaches for preventing these problems will depend on the local climate and style of construction, but the following general rules apply to most crawlspace designs.

1. Keep all untreated wood materials away from the earth.
2. Provide rain drainage, such as gutters, to conduct rainwater away from the house.
3. Slope the earth away from the house for at least 5 feet at a minimum 5% grade (3 inches in 5 feet). Establish drainage swales to direct rainwater around the house.
4. Add a sill gasket to provide air sealing.

WATER-MANAGED CRAWLSPACE FOUNDATION




5. Install a protective membrane, such as an EPDM-type membrane, to serve as a capillary break that reduces wicking of water from the masonry wall. This membrane, in addition to metal flashing, can serve as a termite shield.
6. Dampproof the below-grade portion of the foundation wall to prevent the wall from absorbing ground moisture by capillary action.
7. Install drainage plane material or gravel against the foundation wall to relieve hydrostatic pressure and channel water to the foundation drain.
8. Provide a foundation drainage system at the bottom of the footing, not on top, when the foundation floor (interior grade) is below the exterior grade. Surround a perforated 4-inch drain pipe with gravel and cover them with filter fabric.
9. Install 6-mil polyethylene across the crawlspace floor to prevent soil moisture from migrating into the crawlspace. Overlap and tape all seams by 12 inches, and seal the polyethylene 6 inches up the crawlspace walls.

## CRAWLSPACE WALL INSULATION TECHNIQUES

For years, standard building practice was to insulate underneath the floor over a ventilated, unconditioned crawlspace. A better approach is to build a well sealed, unventilated crawlspace (i.e., build the crawlspace like a basement) by sealing and insulating the foundation walls rather than the subfloor.

Advantages to insulating the crawlspace walls are:

- Problems associated with ventilating the crawlspace are avoided.
- Less insulation is required (around 400 square feet for a 1,000-square-foot crawlspace with 3-foot walls).
- Piping and ductwork are within the conditioned volume of the house so they do not require insulation for energy efficiency or protection against freezing.
- Air sealing between the house and crawlspace is less critical.

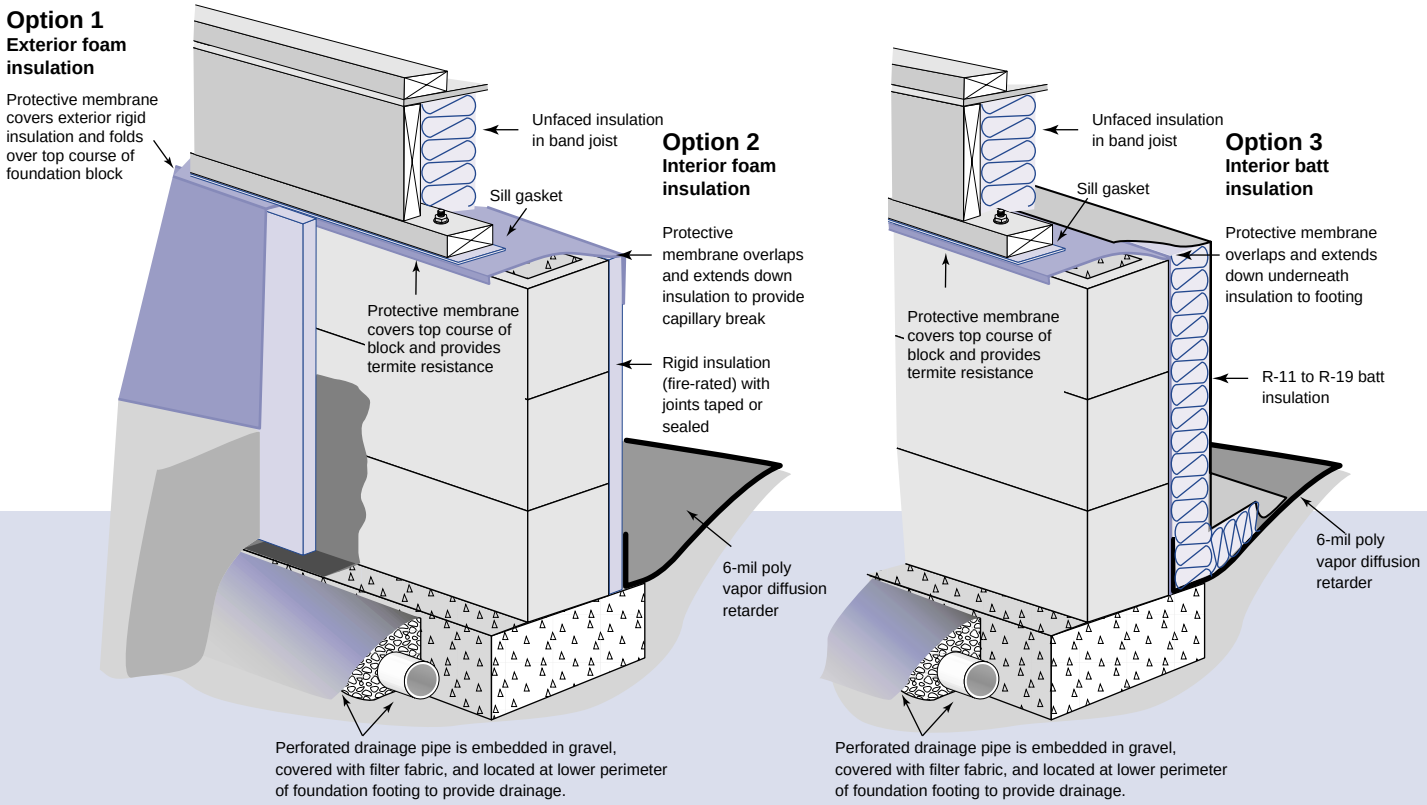
Disadvantages to insulating the crawlspace walls are:

- The insulation may be damaged by rodents, pests, or water.
- A radon mitigation system will require ventilation of the crawlspace to the exterior. Not planning for radon-resistant construction may necessitate air sealing the floor in order to mitigate the radon through ventilation.
- The crawlspace must be built airtight and the air barrier must be maintained.
- The access door to the crawlspace must be located inside the home through the subfloor unless an airtight, insulated access door in the perimeter wall is built and maintained.

## STEPS FOR INSTALLING CRAWLSPACE WALL INSULATION

1. Review plans for this method of foundation insulation with pest control and local building officials to ensure code compliance.
2. Eliminate or seal the foundation vents.
3. Ensure that combustion furnaces and water heaters located in the crawlspace are sealed-combustion units equipped with a powered combustion system.
4. Seal all air leaks through the exterior wall during and after construction, including the band joist.

### INSULATED CRAWL SPACE WALLS—3 OPTIONS

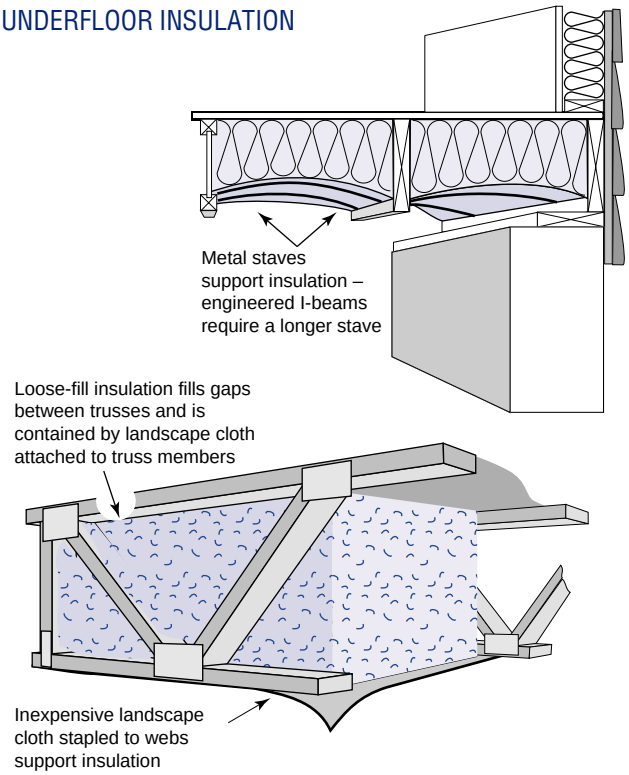


5. Locate the crawlspace access inside the home or install an access through the perimeter that will remain airtight after repeated use.
6. Select insulation levels in accordance with the International Energy Conservation Code or the DOE Insulation Fact Sheet. The Insulation Fact Sheet (DOE/CE-0180) can be ordered from the Energy Efficiency and Renewable Energy Clearinghouse or accessed from the Internet at www.ornl.gov/roofs+walls.
7. Install rigid or batt insulation using one of three options (exterior foam, interior foam, or interior batt) to achieve complete insulation coverage. Insulate the band joist with batt insulation, and the crawlspace access if it is located in the wall. Install a continuous termite shield between the band joist and masonry foundation wall that covers the wall insulation and extends completely outside, or leave a 2- to 4-inch insulation gap at the top for termite inspection.
8. Install a supply outlet in the crawlspace, relying on the leakiness of the floor to provide the return air path.

### STEPS FOR INSTALLING UNDERFLOOR INSULATION

1. During the early phases of construction, meet with the mechanical subcontractors (plumbing, electrical, and heating/cooling) to inform them of the importance of keeping the space between floor joists as clear as possible. Run drain lines, electrical wiring, and ductwork below the bottom of the insulation so that a continuous layer of insulation can be installed. For protection against freezing, supply plumbing may be located within the insulation. The best approach is to run supply plumbing together in a few joist spaces. The insulation can be split and run around the piping.
2. Seal all air leaks between the conditioned area of the home and the crawlspace. High-priority leaks include holes around bathtub drains and other drain lines, plenums for ductwork, and penetrations for electrical wiring, plumbing, and ductwork (including duct boot connections at the floor).
3. Select insulation levels in accordance with the International Energy Conservation Code or the DOE Insulation Fact Sheet.
4. Insulation batts with an attached vapor barrier are usually used to insulate framed floors. Obtain insulation with the proper width for the joist spacing of the floor being insulated. Complete coverage is essential – leave no insulation voids. The batts should be installed flush against the subfloor to eliminate any gaps that may serve as passageways for cold air to flow between the insulation and the subfloor. The batts should be cut to the full length of the joist being insulated and slit to fit around wiring and plumbing. Insulate the band joist area between air ducts and the floor as space permits. Use insulation hangers (wire staves) spaced every 12-18 inches to hold the floor insulation in place without compressing the insulation more than 1 inch.
5. The orientation of the vapor barrier depends on the home's location. In most of the country, the vapor barrier should face upward. However, in certain regions of the Gulf states and other areas with mild winters and hot summers, it should face downward.
6. Insulate all ductwork in the crawlspace.
7. Insulate all hot and cold water lines in the crawlspace unless they are located within the insulation.
8. Close crawlspace vents after making sure the crawlspace is dry and all construction materials have dried out.

UNDERFLOOR INSULATION




- INSULATING TRUSS FLOOR SYSTEMS
  Instead of batt insulation, a better approach is to install netting or rigid insulation to the underside of the floor trusses and fill the space created between the netting or insulation and subfloor with a loose-fill insulation.

# CRAWLSPACE INSULATION

*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*
*865-574-5178*
*www.ornl.gov/ORNL/BTC*

*The International Energy Conservation Code can be obtained from the International Code Council by calling 703-931-4533, www.intlcode.org*

*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.*



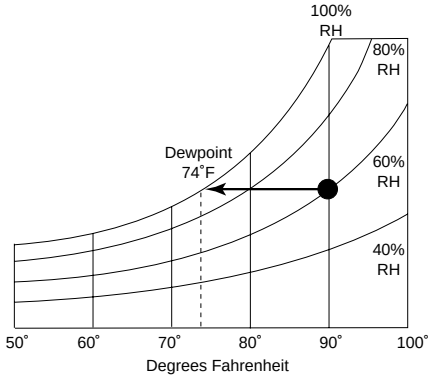
## ARE CRAWLSPACE VENTS NECESSARY?

Most building codes require crawlspace vents to aid in removing moisture from the crawlspace. However, many building professionals are now recognizing that an unvented crawlspace (or closing crawlspace vents after the crawlspace has had time to dry out after construction) is the best option in homes using proper moisture control and exterior drainage techniques for two reasons.

First, ventilation in the winter is undesirable in order to keep crawlspaces warmer. Second, warm, moist outdoor air brought into the crawlspace through foundation vents in the summer is often unable to dehumidify a crawlspace and, in fact, can lead to increased moisture levels in the crawlspace.

For example, a crawlspace kept cool by the ground in the summer may have a temperature of 65°F and 90% relative humidity (RH)—the dew point temperature of the air is 62°F. The dew point of outdoor air at 90°F and 60% RH is about 74°F. Thus, outdoor air brought into the crawlspace will actually increase the moisture level until water condenses out on cool crawlspace surfaces such as floor joists, foundation walls, and air-conditioning ducts. As framing stays moist, mold grows and dry rot develops.

### PSYCROMETRIC CHART

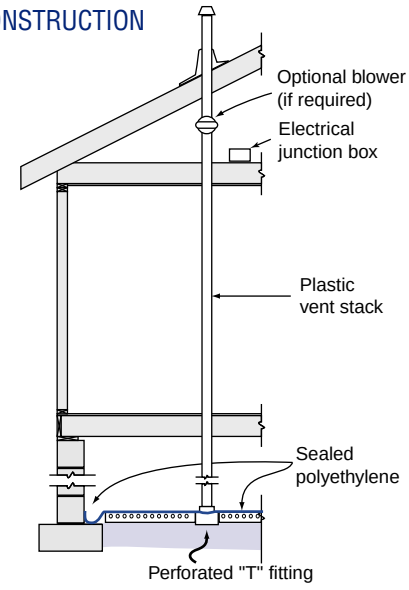



## BUILD IN RADON RESISTANCE

Radon is a radioactive gas that occurs in some soils. It can enter a home through the foundation and floor system. If it occurs in significant concentrations (greater that 4 pico-curies per liter), it may pose a severe health risk to the home occupants. To guard against radon problems:

- Install a sealed, continuous layer of 6-mil polyethylene over the crawlspace floor.
- Install a plastic tee below the polyethylene that protrudes through the polyethylene.
- Install a vertical 3-inch plastic pipe from the foundation to the roof through an interior wall.
- Connect the tee to the vertical 3-inch plastic pipe for passive mitigation.
- Have an electrician stub-in a junction box in the attic.
- Test the bottom conditioned room for radon with an EPA-listed radon test kit, or hire a qualified technician. If the house has a high radon concentration, install an active radon mitigation system by attaching a small blower to the plastic pipe in the attic to expel the gases to the outside.
- If radon levels are especially high (over 25 pico-curies per liter), consult with local radon experts.

### RADON-RESISTANT CONSTRUCTION

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