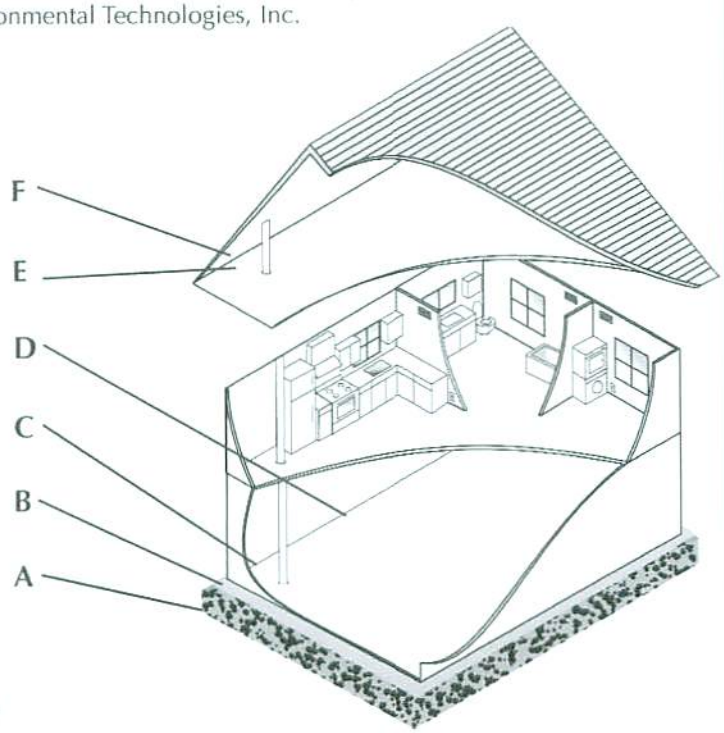
ADC Site Preparation

The following techniques are to be used to prepare the home site prior to installing a HomeAire Active Dampness Control System. These techniques must be followed in order to qualify for the Satisfaction Guarantee provided by HomeAire, a division of Spruce Environmental Technologies, Inc.



Prior to Slab Pour:

A. Put in a layer of **clean gravel** at least 4 inches thick. The gravel should be a size that will pass through a 2-inch sieve but be retained by a ¼-inch sieve.

B. Place **plastic sheeting** on top of the gravel. The sheeting should cover the entire floor area and seams should overlap by at least 12 inches.

C. Before the slab is poured, embed vertically into the sub-slab gravel a 3" or 4" diameter **PVC pipe**. Use a "T" fitting on the bottom of the pipe to ensure that the pipe opening remains in the gravel. (Make sure the "T" fitting does not fill with cement while pouring the slab.)

After Slab Pour:

D. **Fill all large openings** in the slab. Seal all joints.

E. **Route the vent pipe** through the attic in a location where there is enough room to install a fan. Allow at least 2 feet of clearance around the pipe. Make sure the pipe terminates at least 12 inches above the surface of the roof and at least 10 feet away from any door or other opening into the house that is less than 2 feet below the exhaust point. Pipe routing must be as straight as possible. Avoid the use of 90° angles (use two 45° angles instead). It is critical to avoid "traps" in the run.

F. **Install wired electrical junction box** (120 volt AC) next to the anticipated location of the fan.

HomeAire™

Existing Home ADC Suitability Survey

The following questions should be asked before selling an ADC System for an existing house. The more "Yes" answers, the greater the likelihood that the ADC System will perform to the homeowner's satisfaction. This checklist should not be used to override the HomeAire dealer's experience and judgement.

- Is there a layer of clean gravel at least 4 inches thick below the slab?
  - ☐ Yes
  - ☐ No

- Has plastic sheeting been placed on top of the gravel?
  - ☐ Yes
  - ☐ No

- Are the basement walls poured concrete?
  - ☐ Yes
  - ☐ No

- Does the house have central air-conditioning?
  - ☐ Yes
  - ☐ No

- Is the basement free of standing water year-round?
  - ☐ Yes
  - ☐ No

Planning Step 2

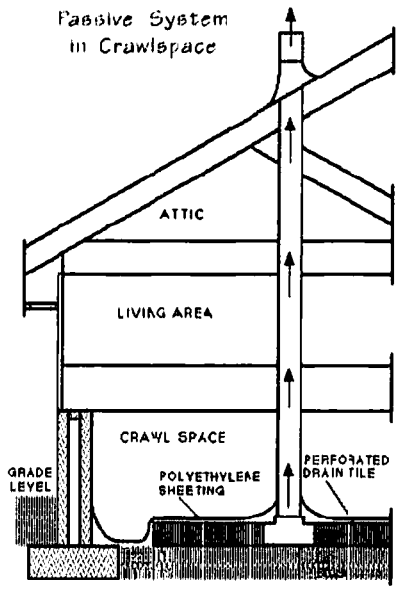
Determine What Type Of System To Install

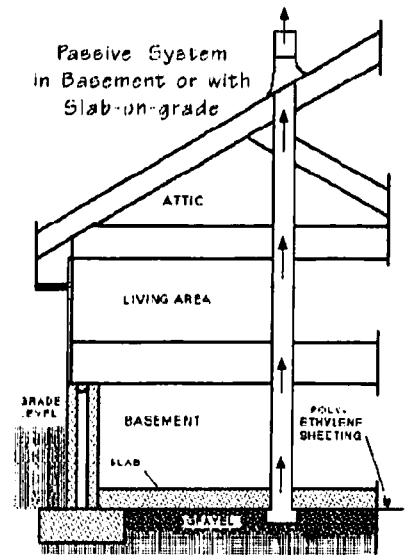
There are three general types of radon-reduction systems that builders have installed.

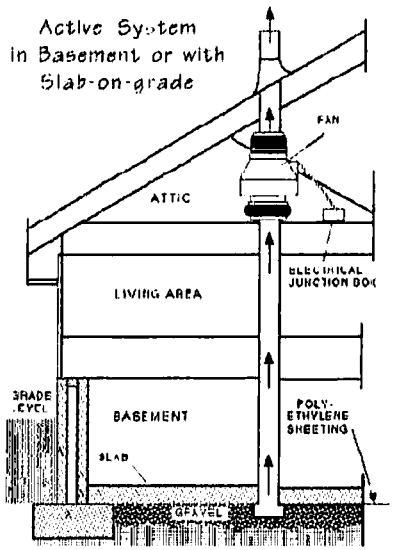
Recommended Option

Passive sub-slab or sub-membrane depressurization system

It is cost-effective and recommended to install a complete passive sub-slab or sub-membrane depressurization system, which would be fully-functioning as soon as construction is finished. The home should be tested after occupancy, and the passive system should be activated if post-occupancy testing reveals radon levels at or above 4 pCi/L.







Upgraded Option

Active sub-slab or sub-membrane depressurization system

Activating a passive system by adding an in-line fan would be an effective upgrade during construction. Virtually all homes with an active system have radon levels below the 4 pCi/L action level.

Not Recommended

Passive system "rough-in"

Some builders perform only the sub-slab preparation and stub the vent pipe above the slab. A vent pipe can be connected and routed through the home and roof later if radon levels are high. **This is not the recommended approach.** It is much more cost-effective to run the vent pipe through the house during construction rather than after the walls have been closed up. *However, if you elect to "rough in" a radon-reduction system, it is important to be clear with the home buyer that the home is not equipped with a functioning system. Be sure to seal off the riser stub so that radon is not being vented into the living space. Also, label the stub so it is not used as a plumbing waste line.*

Planning Step 3

Determine Vent Pipe Location And Size

Route Pipe Through Warm Spaces

The vent pipe exhausts radon collected from beneath the slab or crawlspace. One objective of a radon system in a new home is to install it in such a manner that a natural draft occurs in the pipe to draw the radon from the soil without the use of a fan. To accomplish this, route the pipe up through a warm part of the house and exhaust it through the roof.

Ideally, the vent pipe should be installed in a vertical run, with the least number of elbows which could restrict air flow. A radon vent pipe can also be run through the same chase as the furnace and water heater flue. Do not tie them together, but rather allow for enough room to route the radon vent pipe up alongside the flues with proper clearances consistent with local building and fire codes. This means that the riser should be brought up through the slab within the same room as the furnace or water heater. This requires a little planning on your part to identify this location before the slab is poured and to allow for sufficient room in the chase.

In cold climates, do <u>not</u> route the pipe up through an outside wall. Routing the pipe up an outside wall will reduce the natural thermal stack effect in the vent pipe, reducing its effectiveness. It will also make it difficult to install a fan in the attic if it is needed later on. A better option is to route the pipe up through an interior wall.

In hot climates and predominantly air-conditioned houses, the passive stack will depend more on wind, a hot attic, and sun heating the pipe.

Discharge Location

To prevent radon from re-entering the house or any other nearby buildings, make sure the vent pipe exhausts:

- ✓ a minimum of 12 inches above the surface of the roof
- ✓ a minimum of 10 feet away from any windows or other openings in the building
- ✓ a minimum of 10 feet away from any windows or other openings in adjoining or adjacent buildings

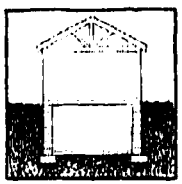
If you are routing the pipe through the same chase as the furnace flue, the vent pipe needs to exit the roof at least 10 feet away from the furnace flue. Plan to elbow the pipe away from the flue in the attic to maintain this separation above the roof. However, the additional elbows and horizontal pipe length will restrict air flow through the pipe if the system is activated. Use 45 degree joints to reduce friction.

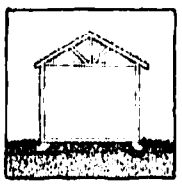
Use 4-inch Pipe When Possible

When deciding between 3-inch and 4-inch pipe (PVC or ABS), the 3-inch pipe size is the minimum you should use. However, 4-inch pipe is the preferred choice for a couple of reasons. Field results have indicated that passive systems tend to function better with 4-inch pipe. A 4-inch pipe will also allow for a quieter system if the system is activated.

The type of system you install also depends on foundation type. Please see the pages listed below which correspond to the type of foundation you will be using.

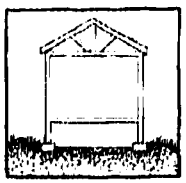
Basement or Slab-on-Grade





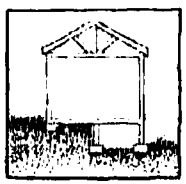
See page 35

Crawlspace



See page 45

Combination Foundation



Treat each foundation separately and use the appropriate techniques for each foundation segment. Pay special attention to the points at which different foundation types join, because soil-gas entry routes exist in such locations. For an alternative, see page 43.

Installation Step 1

Basement and Slab-on-Grade Construction: Sub-Slab Preparation

If the house you are building has a slab-on-grade or basement foundation, the radon gas must be able to move laterally beneath the slab to the location where the vent pipe collects the gas. There are three basic methods for improving soil gas collection beneath slabs.

Gravel

This option is generally chosen in regions of the country where gravel is plentiful and economical or where gravel is required by the building code for water drainage. A continuous four-inch layer of ½-inch to ¾-inch clean (no fines) gravel placed beneath a slab provides a largely unrestricted path for radon to be collected. This size gravel provides a drainage layer and capillary break for moisture control.

For installation guidance, see page 36.

Perforated Pipe Alternative

In some regions of the country, gravel is not a feasible option, either because native soils are sufficiently permeable and gravel is not required for water drainage, or because lack of local supply makes gravel very expensive. One alternative is to use the native fills beneath the slab and lay in a loop of perforated pipe to improve soil gas movement. This method is already employed in some homes with the use of a drain tile loop. The loop of perforated pipe works well because the soil gases need only move to the loop rather than all the way across the slab as in the case of a single collection point.

For installation guidance, see page 38.

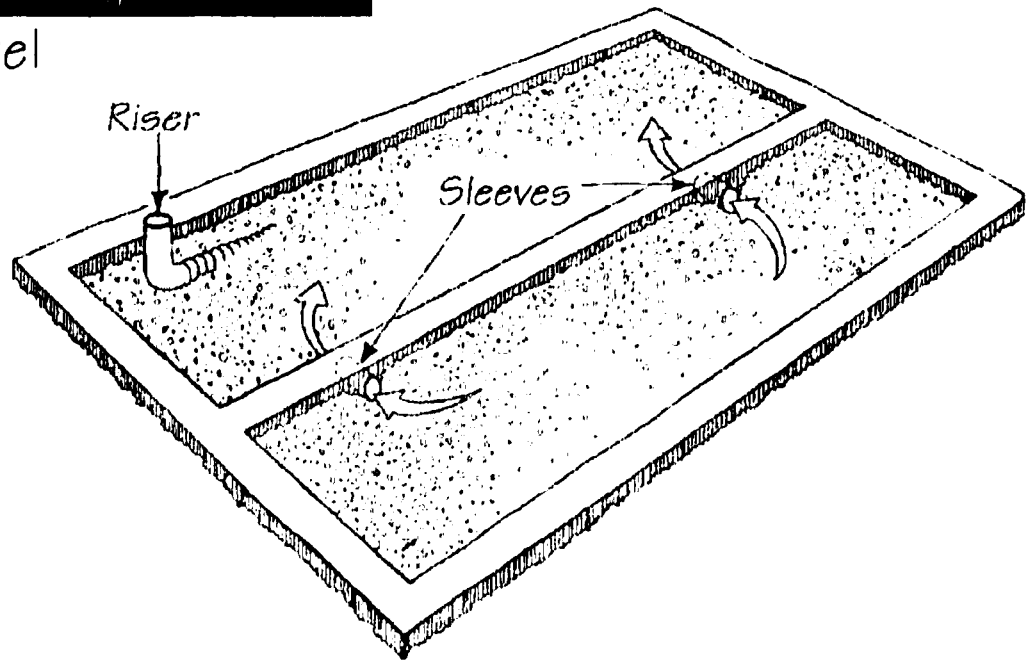
Soil Gas Collection Mat Alternative

In some areas, the perforated pipe option may not be feasible if the labor needed to dig a trench for the pipe loop is too expensive, or if sub-grade soils are compacted or frozen. The third option is to install interconnected strips of drainage mats (soil gas mats) on top of the sub-grade and beneath the slab. Drain mats consist of plastic material that resembles an egg crate. Wrapped around the "egg crate" is a geotextile filter fabric that allows for the passage of air but prevents the infiltration of wet concrete. The mat can be laid directly on top of the prepared sub-grade, which should be a uniform layer of sand (native or fill) a minimum of four inches thick. The concrete can be poured directly over the soil gas collection mat.

For installation guidance, see page 40.

Installation Step 1A

Gravel



Place a uniform layer of clean aggregate under all concrete slabs or floor systems that directly contact the ground and are within the walls of the living spaces. Use a minimum 4-inch thick layer. The gravel should be about ½- to ¾-inch size. Smaller or fine gravel, or gravel that is not as uniform in size, will restrict air movement under the slab.

Grade Beam Obstructions

A grade beam or intermediate footing is often installed beneath a slab to support a load-bearing wall, presenting a barrier to the lateral flow of air beneath the slab to the soil gas collection point. There are a few options that can be used to avoid grade beam obstructions to soil gas air flow.

Option 1

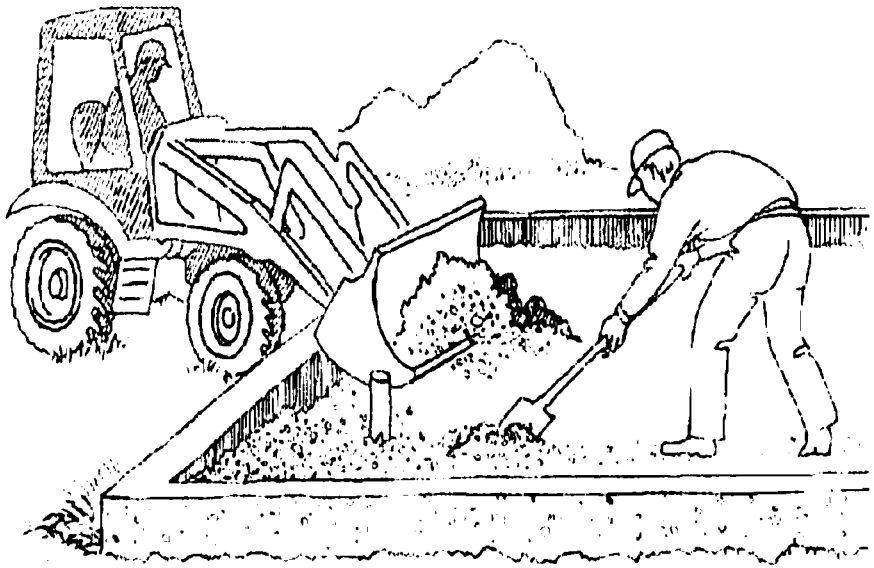
Use post and beam construction by setting teleposts that support overhead beams on pads rather than continuous footings.

Option 2

Provide a means for air to flow through the grade beam. This is can be done by inserting at least two 4-inch pipe sleeves between the form boards or trench and pouring the grade beam over them. A minimum of two pipes should be installed at opposite ends of the grade beam. One pipe should be installed every 10 feet. Tape the ends so concrete does not enter the ends of the pipe while pouring the footing. **Remove** the tape when forms are removed and before connecting to pipe loop if a pipe loop is used.

Option 3

Add a second riser on the other side of the grade beam. Tie the riser into the vertical vent stack or run a second vent stack.



Inserting Vent Pipe In Gravel

Place a 3- or 4-inch TEE fitting at the location where you want the riser to extend through the slab. The size of the TEE or elbow will depend upon the diameter of vent pipe you will be installing.

Connect a short stub, at least 8 inches, of 3- or 4-inch PVC pipe vertically into the TEE.

Recommended Improvement

Soil gas air flow can be somewhat restricted if the pipe is inserted into the gravel, and the gravel fills the pipe, especially if the system is later activated. To allow for airflow over a larger area, lay 3- or 4-inch perforated and corrugated pipe (recommended minimum length of 10 feet) in the gravel and connect it to the radon vent riser TEE fitting. Depending on the location of the riser, an elbow fitting may be used in place of a TEE fitting when using additional piping in the gravel. Make sure that the concrete does not plug up the pipe during pour.

Pipe Alternative

Perforated Pipe

Lay a 3- or 4-inch diameter perforated drain pipe in a trench around the foundation perimeter just inside the foundation footing. This could be the same pipe loop used for under-slab drainage. Be sure the pipe is covered by at least one inch of fill to keep concrete from filling perforations.

What Kind Of Pipe Works Best?

Perforated and corrugated pipe is flexible, which makes it easy to lay down in a trench. The perforations also allow for good soil gas collection. It is recommended that the pipe be covered with a geotextile cloth to prevent fines from clogging the holes.

How Much Pipe Do I Need?

Based on field work, it is recommended to lay a continuous loop of 3- or 4-inch diameter perforated pipe in the sub-grade with the top of the pipe located a nominal one inch below the concrete slab, for slab areas less than 2,000 square feet. The pipe loop should be located approximately 12 inches from the inside of the exterior perimeter foundation walls. For slab areas greater than 2,000 square feet, but less than 4,000 square feet, the same configuration may be used but the pipe size should be a minimum of 4 inches in diameter. Slab designs in excess of 4,000 square feet should have separate loops for each 2,000 to 4,000 square feet depending upon the size of pipe utilized (3-inch or 4-inch).

Install In Loops Rather Than Straight Sections

The reason for laying out the pipe in a loop is to allow for the soil gas to enter the collection pipe from two sides. Also, if the pipe is crushed at one point during the construction, the soil gas will still be drawn to the vent pipe.

Connecting Pipe Loop To Riser

Close the loop by connecting the ends to short pipe stubs and to opposite legs of a 3- or 4-inch PVC TEE. Connect a short stub of 3- or 4-inch PVC pipe vertically into the TEE.

Crossing Grade Beams

In buildings where interior footings or other barriers separate the sub-grade area, the loop of pipe should penetrate, or pass beneath, these interior footings and barriers. Lay the loop before the grade beams are poured, or lay a length of non-perforated but corrugated pipe across the trench before pouring a grade beam. If the latter method is used, tape off the ends of the pipe before pouring the beam, remove the tape after pouring, and finish connecting the loop.

Installation Tip

For a more secure connection, when 3-inch corrugated pipe is used for the loop, the corrugated pipe can be inserted into a 4-inch PVC TEE by securing with sheet metal screws. When 4-inch corrugated pipe is used, 4-inch by 4-inch rubber couplings can be used to connect the perforated pipe to the solid PVC pipe stubs.

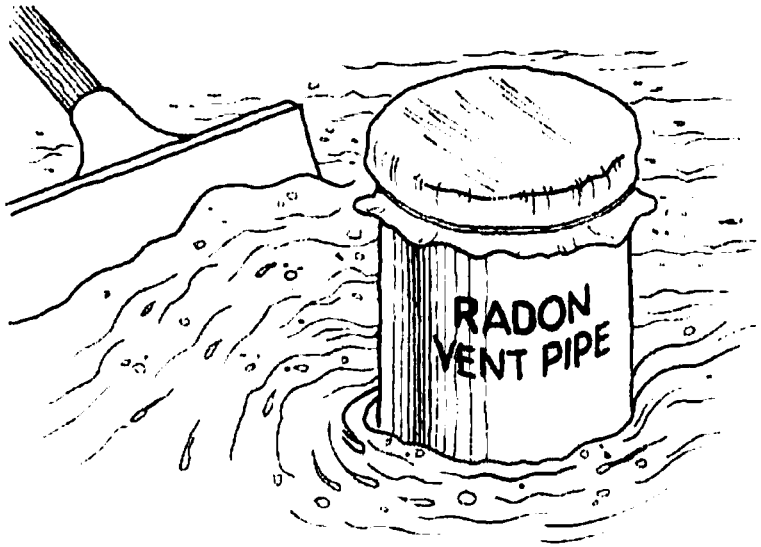
Installation Step 1C

Seal Off And Label Riser Stubs

Regardless of the sub-grade collection method used, you will have a short stub of pipe sticking up to which the vent piping system will later be attached. Care should be taken to cover the end of the pipe so that it does not become filled with concrete when the slab is poured.

Label this stub so that someone does not mistakenly think it is tied to the sewer and set a commode on it.

Support the stub, perhaps off a wall, so that it stays vertical as the wet concrete is poured.



Alternative For Combination Foundations

Some builders have found it to be more economical to tie the different foundations together into a single riser. Place a pipe to connect the sub-grade area to the crawl space in the trench of the intervening footing prior to pouring the foundation walls. This pipe should be 4-inch perforated and corrugated pipe to prevent accumulation of water, which could block air flow. Cover with geotextile cloth. Tape the ends of the cross-over to keep from getting debris in it until the pipe can be connected to the slab and crawlspace systems.

Installation Step 10

Lay Foundation

Foundation walls and slabs should be constructed to reduce potential radon entry routes. In general, openings in walls and slabs should be minimized, and necessary openings and joints should be sealed.

Foundation Walls

In poured concrete walls, all control joints, isolation joints, and any other joints should be caulked with an elastomeric sealant such as polyurethane caulk.

Hollow block masonry walls typically have cavities that can allow radon movement. To prevent this, hollow block walls should be topped with a continuous course of solid block or be grouted solid on the top. Alternatively, use a solid concrete beam at or above the finished ground level or a full sill plate.

Dampproof foundation walls, and seal any penetrations through the walls.

Slab

Pour a strong slab, and take steps to control cracking. Although concrete slabs will almost inevitably crack, control joints can help the concrete to crack in planned locations. As with the foundation walls, all control joints or other joints should be sealed with polyurethane caulk to reduce radon entry.

Do not deliberately puncture holes in the plastic sheeting prior to pouring the slab. Some contractors will do this to allow excess water to drain from the wet concrete. Putting holes in the plastic sheeting decreases (but does not eliminate) its effectiveness as a soil-gas retarder. It is preferable to use concrete with a lower water-to-cement ratio (low slump concrete).

Similarly, some contractors will put a layer of sand on top of the polyethylene, both to protect it and to absorb water from the concrete mix. This practice is not recommended. The sand may become wet, from the concrete or rising ground water, and would have to dry to the interior through the concrete. The presence of the polyethylene sheeting during this drying process may cause moisture problems above the slab.

Trap any condensate or floor drains which pass through the slab, or route them through non-perforated pipe to daylight. Mechanical traps should be used rather than "wet" traps which can dry out.

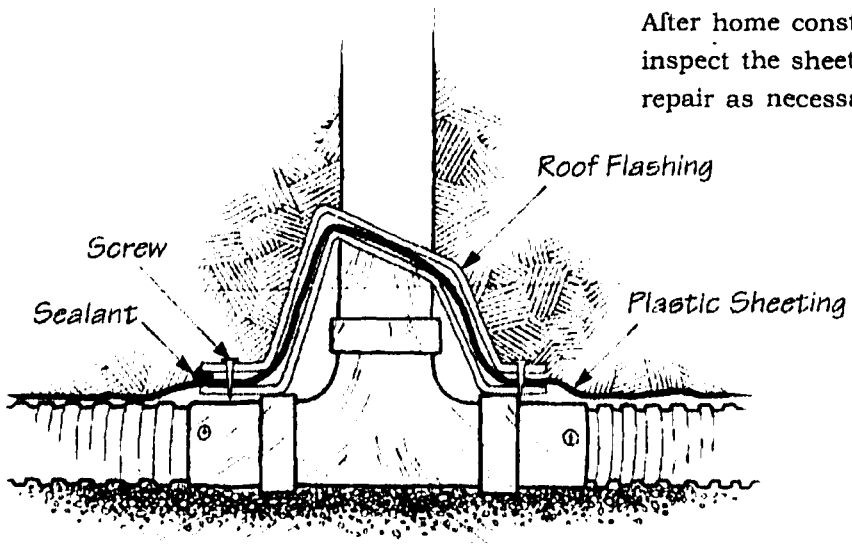
Sump pits which are open to the soil or fed by drain tile loops should be covered with a gasketed lid. For more information on sumps, see page 52.

Crawlspaces Continued

Riser Installation

The vent pipe needs to be connected to the perforated pipe beneath the plastic in a manner that prevents air leakage. The plastic sheeting can be wrapped around the vent pipe and taped to the pipe securely.

Another way to prevent air leakage around the joint is to use two roof flashing hoods. One roof flashing goes below the plastic and one is placed above the plastic to provide a flat area to which the plastic can be sealed. The riser is sealed by the rubber grommet on the roof flashing. The two roof flashings are then secured by sheet metal screws. Depending on the location of the riser, there may be either a PVC TEE or an elbow beneath the plastic that has a short 4-inch stub of pipe to which the corrugated and perforated pipe will be connected.



Label Riser And Plastic

It is a very good idea to label the riser within the crawlspace so it is not confused with any other plumbing. It is also a good idea to label the plastic to state that the plastic should not be removed and, if cut, it should be patched or replaced.

After home construction is completed, inspect the sheeting for damage and repair as necessary.

Installation Step 4 Continued

Allow For Future Installation Of Fan

Although passive radon systems are effective for reducing radon levels by an average of about 50%, it is always a good idea to plan ahead in case adding an in-line fan is needed for further radon reduction to bring indoor levels below 4.0 pCi/L, or in case the future occupant wants to lower the radon levels as much as possible. During installation of the vent pipe, consider these criteria for locating a future fan:

- ✓ Fan cannot be inside the living space of the house.
- ✓ Fan cannot be in the crawlspace beneath the home.
- ✓ Fans are most often located in attics or garages (unless there is living space above the garage).
- ✓ Fans require a 30-inch vertical run of pipe for installation.
- ✓ Fans require an unswitched electrical junction box.

Maintain Fire Resistive Rating Of Walls And Ceilings

If you route your vent pipe through the wall between the house and the garage, you will need to put a fire-barrier around the pipe (on the inside of the garage) to maintain the integrity of the wall. Install a fire barrier with a rating equal to the wall.

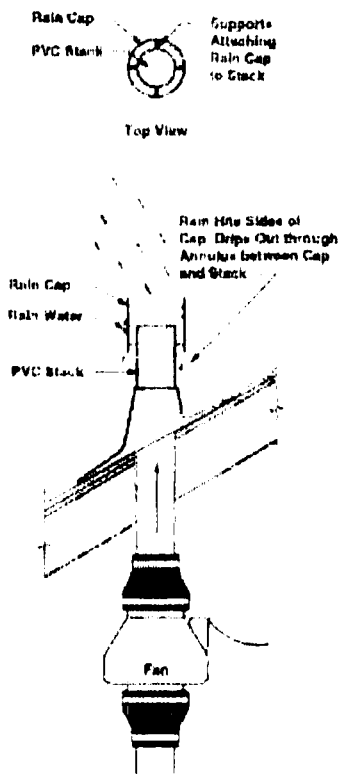
Note that some ceilings are also fire rated ceilings and will require fire barriers as well.

Label Radon Vent Pipe

Label the exposed portions of the pipe so other people will know that the pipe is not part of the sewer system during construction. It is recommended that the radon vent system be labeled in a conspicuous location on each floor level. Also, occupants and future occupants will know that it is part of a "radon vent system."

Places to label include:

- ✓ Where riser exits slab
- ✓ Where pipe is seen in closets
- ✓ Pipe run through attic



Recommended Improvement: Screen On Discharge

It is a good idea to put a 1/4-inch mesh screen on the discharge to keep birds from nesting in the pipe.

Rain caps can reduce radon flow and can force radon (if the system is activated) back down towards the openings into the living spaces. In most areas, they are not needed. For very high rainfall areas, use alternative special devices which prevent large amounts of rain from entering the system while still allowing the air to vent up and away from the building. These devices are available through radon mitigation supply distributors. Another design option, which is more commonly used with commercial applications than with residential installations, is an annular rain cap as pictured here.

Installation Tip

Support the pipe

Support the pipe using plumbers strapping at least once every 6 feet in horizontal runs and once every 8 feet in vertical runs.

Insulate the pipe

In cold climates, insulate the pipe where the pipe is routed through unheated spaces, such as the attic.

Installation Step 6

Install Electrical Junction Box

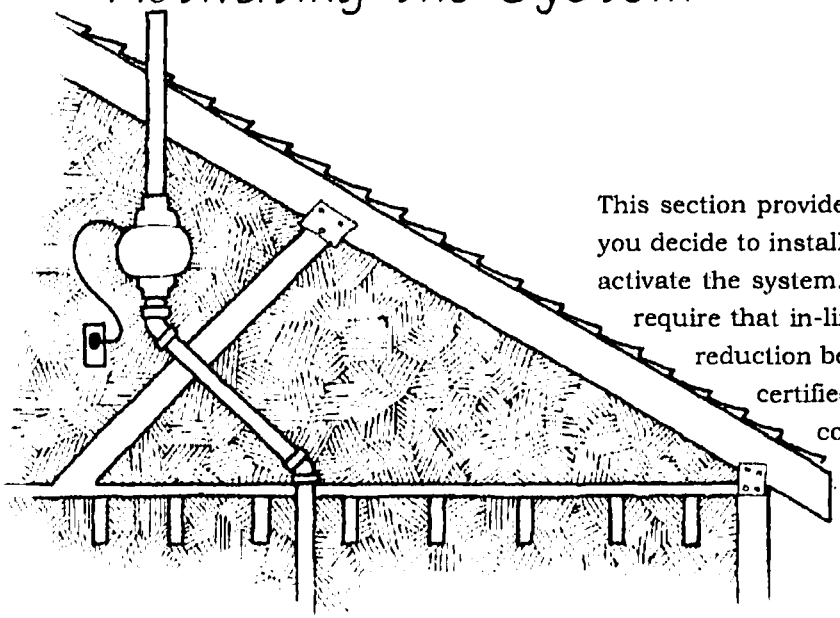
For Future Installation of Fan

Although in most cases the passive system alone is enough to keep radon levels below 4 pCi/L, occasionally the homeowner will want or need to activate the system by adding a fan to further lower radon levels in the home. To prepare for this possibility, pre-wire the attic when installing a passive system. An unswitched electrical junction box should be installed in the attic or garage within 6 feet of the vent pipe. (See page 56 for a discussion about fan installation location.)

For attics with interior access, many building codes require a light in the attic. In these cases, if the junction box for the light is located at an appropriate location for the fan, another junction box will not be necessary. If not, wiring the additional outlet will be simple. The fan outlet does not require a dedicated circuit; it may branch off the existing circuit for the light.

Optional Step 8

Activating the System



This section provides basic guidelines if you decide to install an in-line fan to activate the system. Some states require that in-line fans for radon reduction be installed by a certified radon mitigation contractor. Call your state radon contact for a list of certified contractors (see Appendix D for a list of phone numbers).

Location

The fan and all positively pressurized portions of the vent pipe should be located outside habitable space in the building.

The ideal location is in the attic, or, perhaps, in an attached garage, where the fan housing and vent pipe can be sheltered from the elements, yet be outside the building's conditioned spaces. Sheltering the fan maximizes its efficiency and life expectancy by minimizing exposure to extreme temperatures and moisture. Placement in a non-conditioned space prevents the accidental pumping of radon directly into a home should a leak occur in the fan housing or at the vent-pipe joints.

Building designs that call for a flat roof or cathedral ceiling, or some other design feature that makes the attic installation unworkable, may necessitate placing the fan on the roof or in an exterior venting pipe.

Appropriate fan locations:
- ✓ Unoccupied attic
- ✓ Outside the house
- ✓ In garage

Inappropriate fan locations:
- ✗ In crawlspace
- ✗ In basement
- ✗ In occupied attic